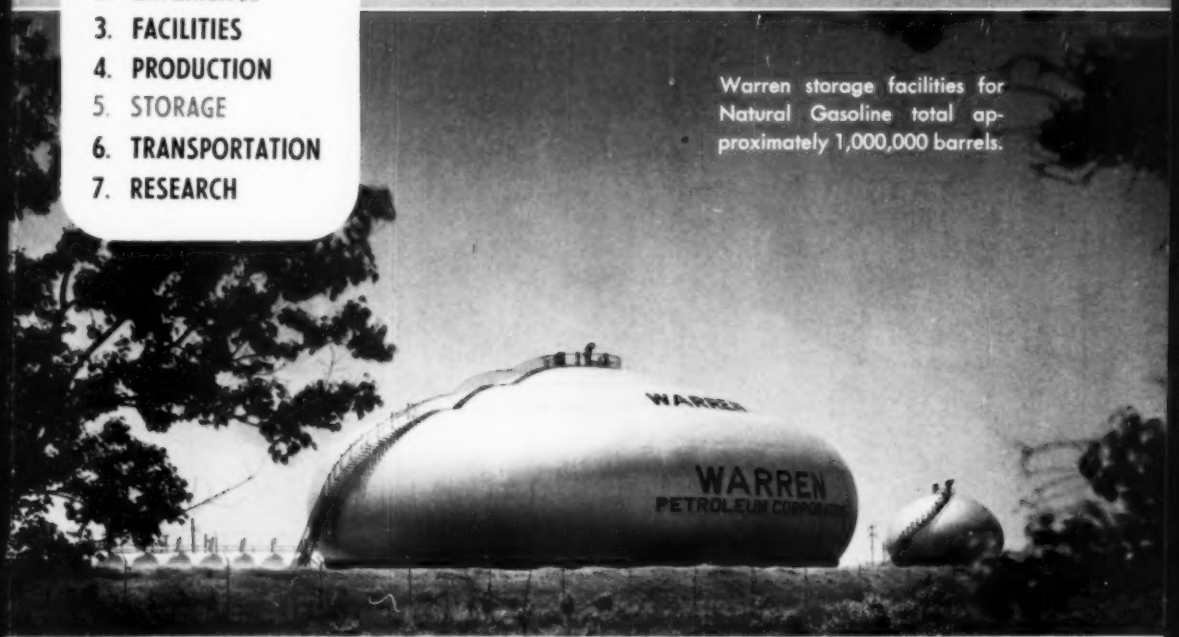
PETROLEUM REFINER

MAY, 19

SPECIALIZED FOR REFINING, NATURAL GASOLINE, AND PETRO-CHEMICAL ENGINEERING, OPERATION AND MANAGEMENT

7 Reasons WHY IT'S WARREN

1. PERSONNEL
2. EXPERIENCE
3. FACILITIES
4. PRODUCTION
5. STORAGE
6. TRANSPORTATION
7. RESEARCH



WARREN PETROLEUM CORPORATION

Producers, Manufacturers, Exporters and Marketers

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TULSA 2, OKLAHOMA CABLE ADDRESSES: Stavolene, Warren

Crude Oil, Natural Gasoline and Liquefied Petroleum Products

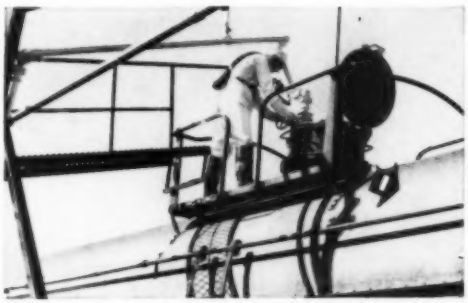
An Idea . . . THAT WENT TO WORK!

SHELL OIL ADDS T.E.L. FLUID

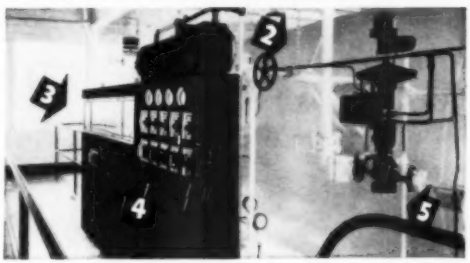
Automatically

AT WOOD RIVER PIPELINE STATION

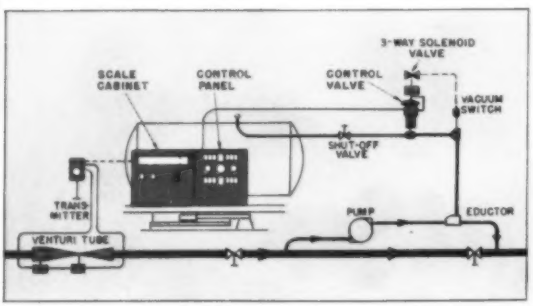
%Proportioneers, Inc.% Loss-In-Weight T.E.L. Blender has proven an economical answer to the problem of supplying leaded gasoline to pipeline facilities. Payout is most attractive when compared with in-tank blending. Each installation is carefully engineered and approved for the specific job requirements. Call in %Proportioneers, Inc.% for engineering advice and equipment.



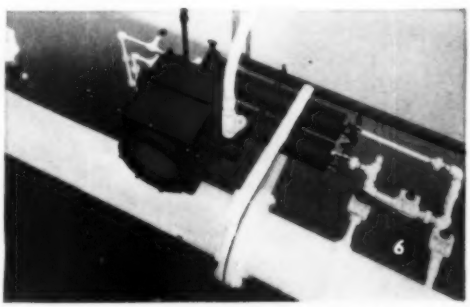
1—T.E.L. Fluid is drawn under vacuum from tank car.



2 Fluid storage tank on standard scale. 3—%Proportioneers, Inc.% Automatic and Flow Responsive Loss-In-Weight Proportioning Scales. 4—Complete alarm panel fully protects system. 5—Specially designed Diaphragm Control Valve for T.E.L. Fluid.



All equipment shown red in photos and flowgram furnished by %Proportioneers, Inc.%



6—Venturi Meter measures gasoline flow through pipeline and maintains uniform pre-set lead treatment.

No. 2 in a series on T.E.L. blending.

% PROPORTIONEERS, INC. %

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PETROLEUM REFINER and The REFINERY CATALOG
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and The COMPOSITE CATALOG
for the drilling-producing-pipe line industry

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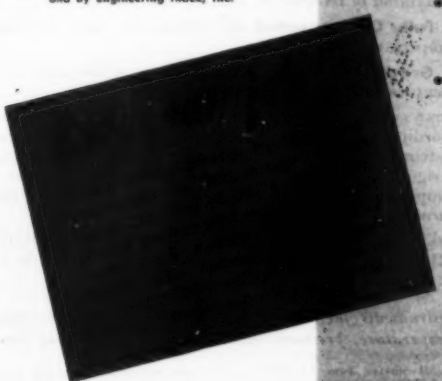

PETROLEUM REFINER

Specialized for Refining, Natural Gasoline and Petrochemical Engineering, Operation and Management

R. L. DUDLEY, President, Publisher A. L. BURNS, General Manager

VOLUME 28, NO. 5 May, 1949

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TRANS

...with

Taylor's new force-balance temperature transmitter is faster, needs little maintenance, has a tiny bulb and short, shiftable range spans

HERE is a new kind of instrument that pneumatically transmits temperature as far as 1000 feet—with an extremely high degree of accuracy! Thermal element gives 63% response in less than 2 seconds (agitated water).

In addition, Speed-Act,— an entirely new technique in temperature measurement — may be added to compensate for unusual thermal lags such as occur in applications requiring separable wells.

COMPARE TRANSAIRE'S* 9 OUTSTANDING FEATURES:

1. Faster—Unprecedented speed of response.

2. Tiny, "cigarette size" bulb is more adaptable to confined space, contributes to fast speed of response. $\frac{3}{8}$" by 3" or $\frac{1}{2}$" by $3\frac{7}{16}$".

3. Short, shiftable range spans:

(a) Standard range span of 50° available where you need exceptionally close readings. Other operating range spans: 100°, 200 and 400°F.; or 25°, 50°, 100° and 200°C. Overall temperature limits from minus 375° to plus 1000°F. or minus 200°C to plus 500°C.

(b) You can shift 50° span with screwdriver from 0 to 50° to 50° to 100°, or 100° to 150°, or any intermediate 50°F. interval. Other spans similarly adjusted.

(c) Range limits interchangeable by substitution of new spring assembly, giving much greater flexibility.

4. Little or no maintenance needed. Force-balance principle practically eliminates wear. Instrument may be quickly adapted to different operating conditions by interchangeable thermal system, spring assemblies and manifold. Permits low inventory of components.

5. Eliminates all electrical hazards in explosive atmospheres.

6. Positive-acting Pilot Valve—Taylor FULSCOPE Relay Air Valve assures quick changes in transmission pressure, overcomes effect of minor leaks.

7. Fixed and Linear Output Range—3 to 15 psi output for full temperature span is linear to 0.012 psi. Fixed output pressure span *eliminates need for individual calibration of receivers or receiver-controllers.*

8. Fully Compensated for barometric and ambient temperature changes.

9. Great Overrange Protection — withstands temperatures of 1000°F, regardless of range.

TRANSAIRE* with SPEED-ACT is one more step in Taylor's coordinated program for developing better industrial instrumentation. It grew from intensive research and design effort which had just one purpose: to produce a temperature transmitter *unsurpassed in accuracy and durability.*

Ask your Taylor Field Engineer! Or write for **Bulletin 98140.** Taylor Instrument Companies, Rochester, N. Y., or Toronto, Canada.

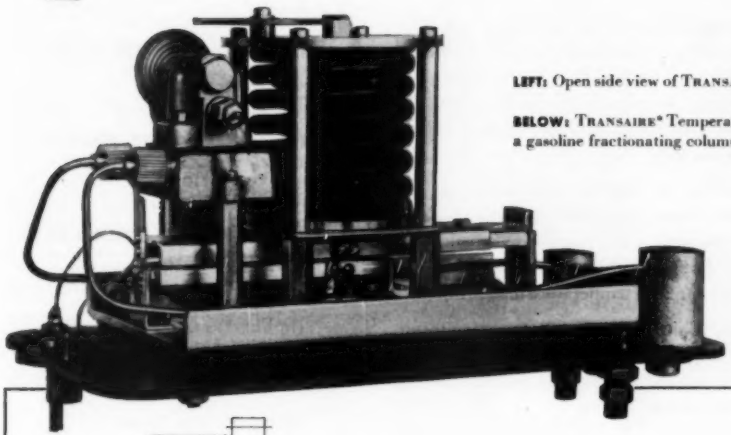
• • •

Instruments for indicating, recording and controlling temperature, pressure, humidity, flow and liquid level.

PETROLEUM REFINER, published every month. Entered as second class mail matter June 16, 1923, at the post office at Houston, Texas, under act of March 3, 1879.

AIRE*!

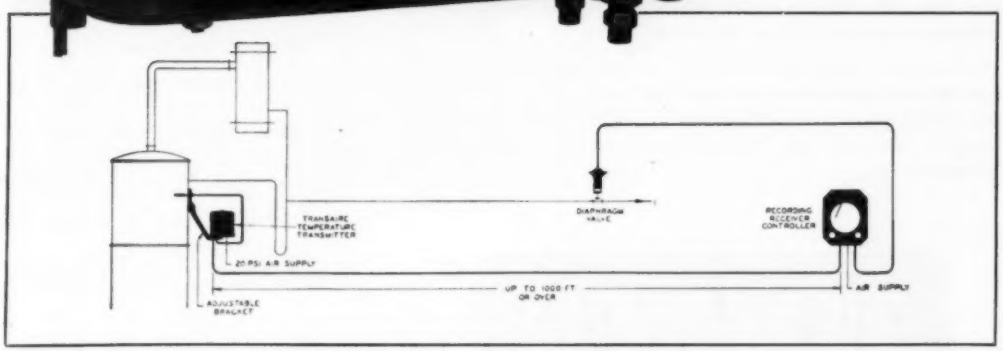
Speed-Act!



LEFT: Open side view of TRANSAIRE* Temperature Transmitter.

BELOW: TRANSAIRE* Temperature Transmitter in operation on a gasoline fractionating column.

* Trade-Mark



QUICK PICTURE OF FORCE BALANCE

TRANSAIRE* consists of *four* main assemblies:

1. A unique gas thermal system which provides force necessary to actuate transmitter.
2. A simple lever which transmits the force of the thermal system to operate the baffle—no pivots used!
3. A spring and compensating bellows assembly which balances the initial pressure in thermal system and compensates for barometric and temperature changes.
4. A balancing pneumatic circuit consisting of a bellows, baffle, nozzle and relay valve. These convert force developed by lever to precisely proportion output air pressure according to measured temperature.

Taylor Instruments

MEAN

ACCURACY FIRST

IN HOME AND INDUSTRY

How do your high temperature tubes stack up for LIFE/COST ratio?

PERHAPS your tubes are doing their job, but are they doing it at the lowest possible cost? It will pay you to look into these twelve Timken® high temperature steels . . . "tailored" to fit your requirements. They are specially developed to cope with specific problems of heat, pressure, corrosion, and oxidation. And *one* of them offers you the best life/cost ratio for your job.

Timken metallurgists, backed by 19 years of experience and research in high temperature applications, are qualified to recommend the one steel that will give you the service life you need at the lowest possible cost. The Timken Technical Staff, recognized authorities in the field, will be glad to help you with your high temperature tube problems.

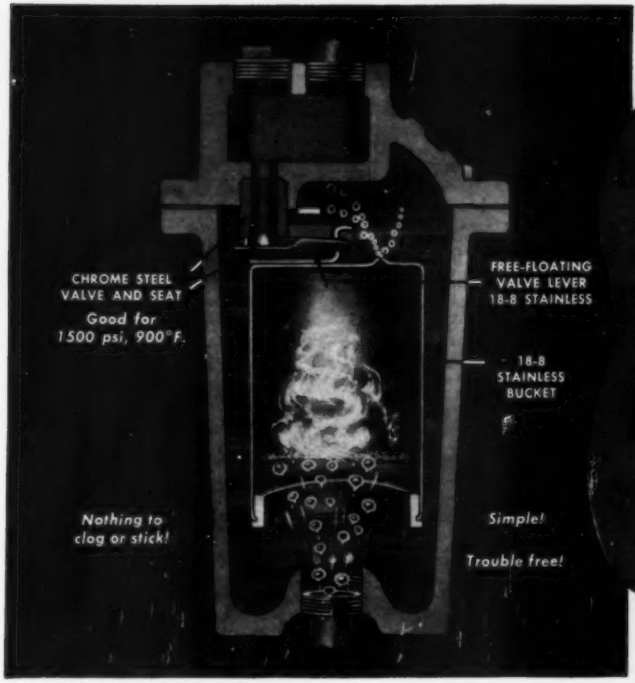
Whichever analysis is selected, you can be assured of uniform high quality steel from shipment to shipment. The Timken Company insures this uniformity through complete and careful quality control from melt shop through final inspection.

Call on the Timken Technical Staff now for help in choosing the most efficient high temperature tube with the best life/cost ratio for you. There's no obligation. Write today to The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

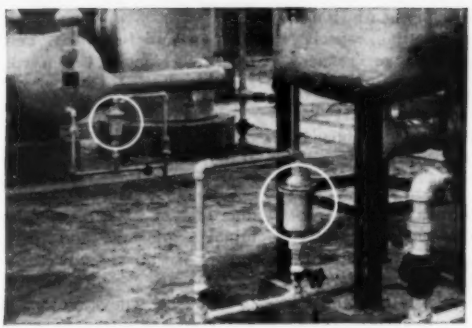
TIMKEN 12-8 STEEL TUBING Shows the best combination of creep strength, oil corrosion resistance and oxidation
TIMKEN SICROMO 9 M STEEL TUBING This steel possesses the maximum corrosion resistance of any of the
TIMKEN SICROMO 7 STEEL TUBING For applications requiring better corrosion resistance than can be obtained
TIMKEN SICROMO 5 S STEEL TUBING For oxidation resistance to 1500°F. Good creep strength and corrosion re-
TIMKEN 4-6% CR MO STEEL TUBING For service up to 1200°F. Superior corrosion resistance. Less oxidation resistance
TIMKEN SICROMO 5 STEEL TUBING For service up to 1200°F. Has excellent oxidation resistance and good corrosion
TIMKEN 2¼% CR-1.0% MO STEEL TUBING For service up to 1150°F. Has greater resistance to creep than 2% Cr.
TIMKEN SICROMO 2 STEEL TUBING For service up to 1200°F. where better scale resistance is required than can be
TIMKEN 2% CR ½% MO STEEL TUBING For service up to 1150°F. Intermediate corrosion resistance plus good
TIMKEN DM STEEL TUBING For service up to 1150°F. This steel offers outstanding creep strength.
TIMKEN CARBON-MO STEEL TUBING For temperatures up to 1000°F. Improved creep strength makes it safer
TIMKEN CARBON STEEL TUBING Generally for service not exceeding 900°F., where corrosion and oxidation

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

Specialists in alloy steel—including hot rolled and cold finished alloy steel bars—a complete range of stainless, graphitic and standard tool analyses—and alloy and stainless seamless steel tubing



it isn't the cost or the upkeep with ARMSTRONG STEAM TRAPS



IF the first cost of Armstrong Steam Traps was high, which it isn't, they would still be a good buy because of low upkeep.* Maintenance on Armstrong Steam Traps is exceptionally low because:

1. Even in Armstrong Steam Traps for low and medium pressures, the valve and seat are chrome steel, hardened, ground and lapped to leak-tight fit—identical in materials and workmanship to those used in Armstrong traps for pressures to 1500 psi, 900°F.

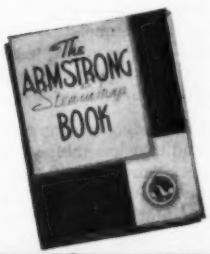
2. The Armstrong free-floating valve lever mechanism is unusually resistant to wear because there is no friction and it is of heavy corrosion-resistant stainless construction.

3. Dirt is washed through the trap by the swirling action of the condensate—and out through the nice big valve orifice.

4. There is nothing to clog, stick, bind or collapse.

Add up these features and you arrive at a trap that very seldom needs maintenance—a trap that saves man hours and money—a trap that pleases everybody from the purchasing agent to the pipe fitter.

THE 36-page ARMSTRONG STEAM TRAP BOOK tells all about these traps, how to select and install them for long, trouble-free performance. Send for your copy.



*You get more hot condensate capacity with Armstrong Steam Traps per dollar of investment than with any others.

P.S. Because they don't leak steam, Armstrong Traps are excellent for saving fuel.

Send for the Steam Trap Book!

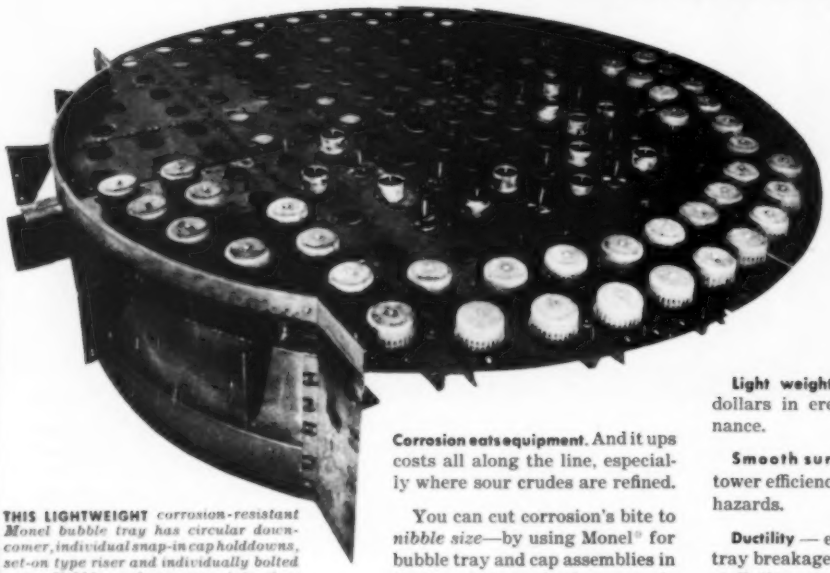
ARMSTRONG MACHINE WORKS
852 Maple St., Three Rivers, Michigan

ARMSTRONG STEAM TRAPS

Factory Representatives in 48 Key Cities... Traps Stocked at 147 Points

Lightweight MONEL Bubble Trays and Caps

RESIST CORROSION
REDUCE COKING
CUT EXPLOSION DAMAGE



THIS LIGHTWEIGHT *corrosion-resistant Monel bubble tray has circular downcomer, individual snap-in cap holddowns, set-on type riser and individually bolted caps. Holddown frogs snap into riser openings, and can be installed or removed from top of deck.* PHOTO COURTESY OF THE FABRICATOR, FRITZ W. GLITSCH & SONS, DALLAS, TEXAS.

Corrosion eats equipment. And it ups costs all along the line, especially where sour crudes are refined.

You can cut corrosion's bite to *nibble size*—by using Monel* for bubble tray and cap assemblies in the top sections of primary crude towers.

In these sections where, at temperatures below 500°F., dilute hydrochloric acid plays havoc with most materials, Monel offers an ideal economical solution. Monel's resistance to corrosion attack promotes a lasting, smooth, coke-resisting surface. Its high strength and low corrosion rate make possible the use of thin, lightweight sections which save you money both in material costs and in tower design.

The Glitsch "Truss-Type" bubble tray illustrated above makes possible these advantages of wrought Monel construction . . .

Light weight—saves time and dollars in erection and maintenance.

Smooth surfaces—increases tower efficiency . . . lessens coking hazards.

Ductility — eliminates cap and tray breakage in cleaning and installation.

Safety—the light weight and ductility of Monel trays allow minor explosions and pressure surges within the tower to expend themselves without damage to the vessel. They greatly reduce the hazard to workers entering a vessel which has undergone an explosion. And Monel trays and caps, distorted by an explosion, may be easily straightened in the field and returned to service.

So before you choose any metal for cap and tray assemblies, consider the advantages of Monel. Write for information and technical data relating to Inco Nickel Alloys in refining equipment.

EMBLEM OF SERVICE

INCO
TRADE MARK

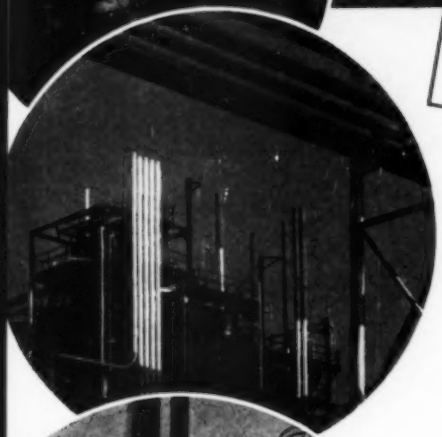
THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

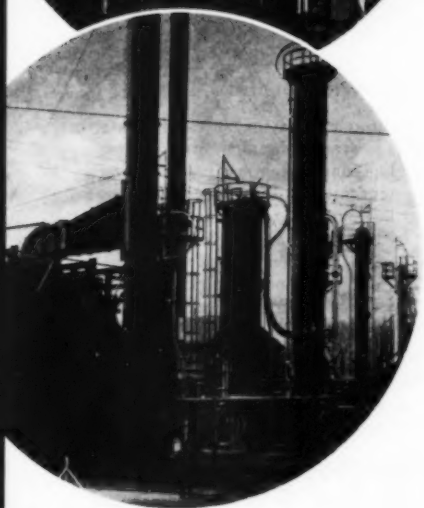
*Reg. U. S. Pat. Off.

MONEL . . . *for minimum maintenance and replacement*

Easy, proven way

TO SELECT THE PROPER REFINERY TUBING FOR YOUR PLANT





NATIONAL'S *25 different* ANALYSES Cover Practically Every Condition of Temperature, Pressure, Corrosion and Exposure

● When the question of tubing comes up for a new installation or for replacement, don't cross your fingers and "take a shot in the dark," hoping that your choice will be right. Come to Tubing Headquarters. Tell us what conditions are at your plant . . . what you expect of the pipe and tubing you buy. The chances are that we have already helped someone handle a similar situation . . . *and successfully*. In fact our files are filled with case histories, the results of laboratory tests, and actual field observations involving U·S·S NATIONAL Pipe and Tubing under practically every condition of temperature, pressure, corrosion and exposure.

Out of all this research and study have come important developments in tubing steel which enable NATIONAL to now offer you Seamless Steel Tubes, Condenser Tubes, Heat Exchanger Tubes, and Refinery Piping in *25 different analyses*. Each of these 25 different analyses has been performance-proved to meet the specific conditions of corrosion and oxidation for which it is recommended.

FOR STILL TUBES · CONDENSER TUBES
HEAT EXCHANGER TUBES · REFINERY PIPING

- Low Carbon
- Low Carbon, ½ Moly.
- Low Carbon, 1 Moly.
- ½ Cr., ½ Moly
- 1¼ Cr., ½ Moly
- 2 Cr., ½ Moly
- 2 Cr., ½ Moly., 1¼ Sil.
- 2¼ Cr., 1 Moly.
- 2½ Cr., ½ Moly., ¾ Sil.
- 3-Cr., ½ Moly., 1¼ Sil.
- 3-Cr., 1 Moly.
- 5 Cr., ½ Moly.
- 5 Cr., ½ Moly., 1½ Sil.
- 5 Cr., ½ Moly., Titanium
- 5 Cr., ½ Moly., Columbium
- 7 Cr., ½ Moly.
- 8 Cr., 1 Moly.
- 9 Cr., 1 Moly.
- 12 Cr., Aluminum
- 17 Cr.
- 18-8
- 18-8 Titanium
- 18-8 Columbium
- 18-8 Molybdenum
- 25-20

We invite you to bring your problems to NATIONAL. Our Tubing Specialists will work closely with your own engineers to see that you get just the right tubes and piping for your particular requirements.

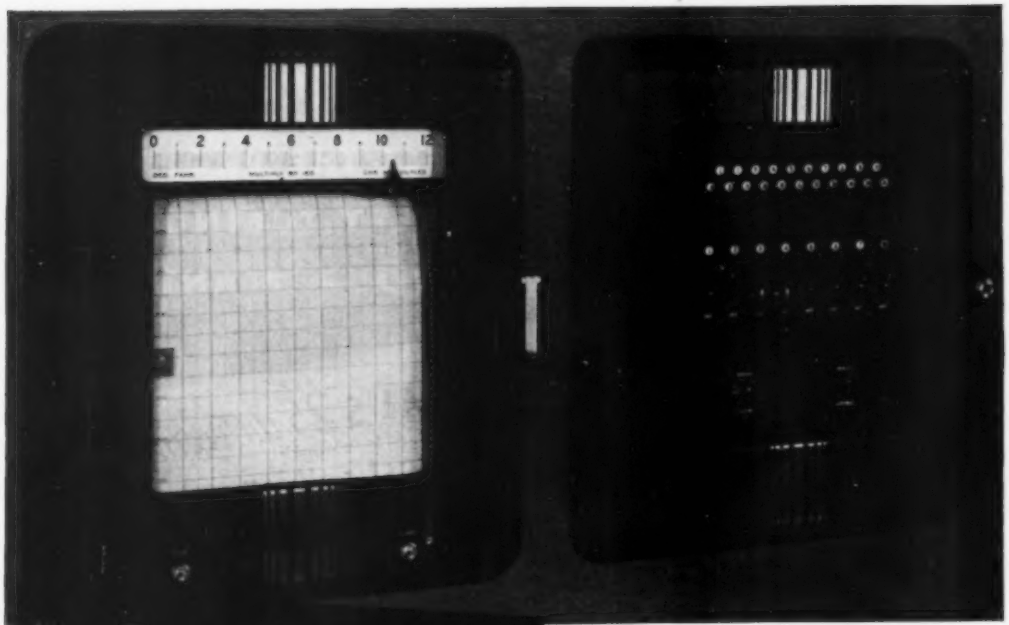
NATIONAL TUBE COMPANY, PITTSBURGH, PA.
(TUBING SPECIALTIES DIVISION)
COLUMBIA STEEL COMPANY, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

MADE WITHOUT WELDS

USS

NATIONAL SEAMLESS PIPE AND TUBES

UNITED STATES STEEL



New Temperature Instrument For Testing and Processing

Checks 160 Points In Only 10.6 Minutes!

Remarkably fast, this new Speedomax is industry's new version of the well-known L&N wartime Flight Test Recorder. It offers a definite advance in temperature checking and recording for the chemical processing industries. With Speedomax, an operator can "tour" the temperatures of 160 points in a little less than eleven minutes. He can watch the readings as they are automatically indicated; or Speedomax will record them for later examination and for the shift log.

In either case, readings are supplied in such rapid rotation that it is generally possible to determine the exact point at which any high or low temperature first develops, even though the condition may later spread to other points. Such speed of course helps both to detect and to isolate trouble.

The installation procedure is entirely standard. The user's staff simply installs thermocouples at those points from which they wish to get temperature readings. Couples are then connected to the Speedomax equipment in banks of 20 each, with as many as 8 banks. Appropriate alarms may be included.

Records When Desired

The Speedomax automatically measures at a rate of one point every 4 seconds. Signal lights wink on for each couple, and as long as temperature remains correct the instrument merely indicates . . . does not record. It can be made to record at any time, however, merely by throwing a switch. Or if any temperature reaches its predetermined limit, an alarm sounds and the Speedomax automatically records until switched off. Also, any bank or banks of couples can be switched out at any time, thus concentrating on areas of special interest.

For further information about this versatile temperature-checking equipment, write Leeds & Northrup Co., 4923 Stenton Ave., Phila. 44, Penna.

Substantially the same equipment can be used for Machine, Turbine and Generator-Bearing Temperatures.

MEASURING INSTRUMENTS • TELEMETERS • AUTOMATIC CONTROLS • HEAT-TREATING FURNACES

LEEDS & NORTHRUP CO.

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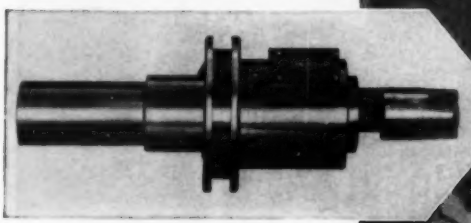
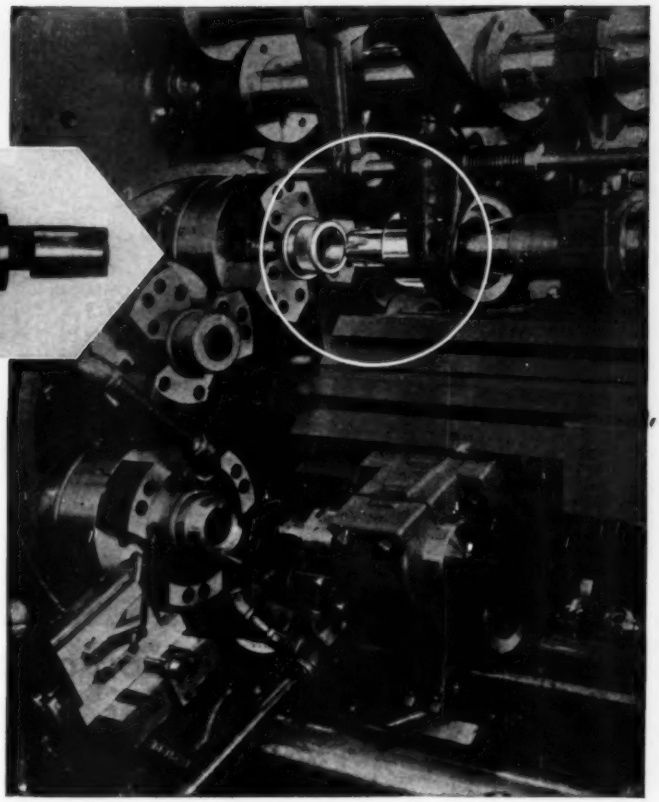
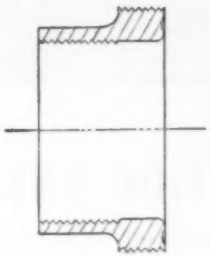
IMPROVED LANDIS TAP...





• CUTS INTERNAL TAPERED THREADS AT 30 FEET PER MINUTE.



Using the new Landis Style LL Receding Chaser Collapsible Tap on an automatic screw machine, 2" 11½ pitch tapered pipe threads 1-5/16" long are tapped in quick change unions for oil field use at the rate of 30 feet per minute. The unions are cold worked forging 2⅜" in diameter of 185-220 Brinell hardness. The same piece is also made of malleable iron, and tapered threads are tapped at the rate of 120 feet per minute.

The LL Taps are designed primarily for tapping tapered threads to A.P.I. standards. An outstanding feature is the detachable tap head permitting the use of various size tap heads to cover a wide range of thread sizes with a minimum amount of equipment.

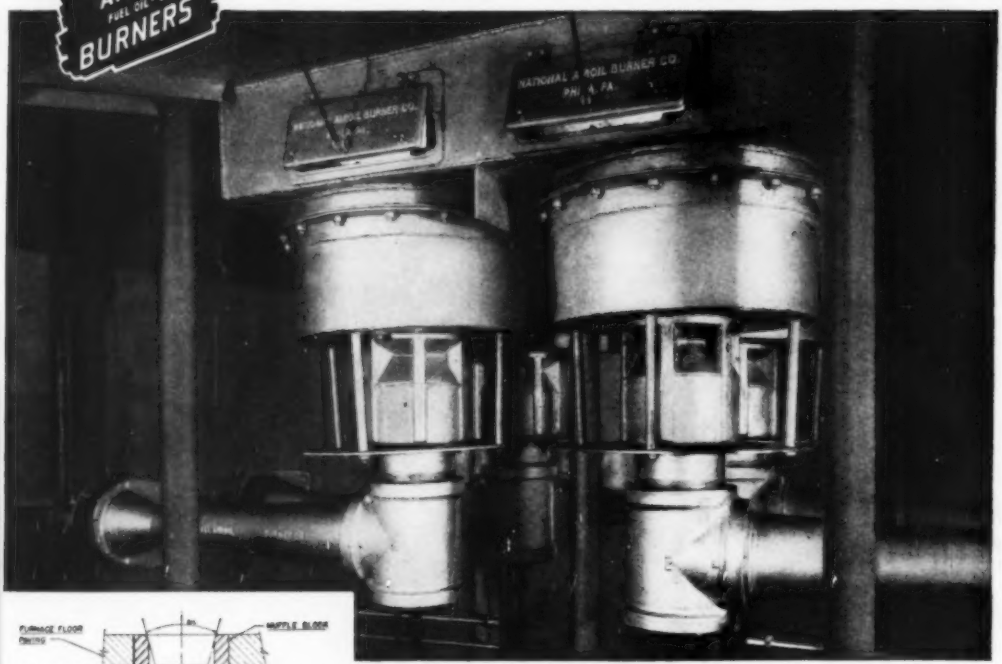
In the improved Style ALM Heads, where an even number of chasers is used, no two chasers are directly opposite each other. This adds greater rigidity for the tap and permits the use of greater radial clearance, giving a freer cutting action with resulting increased chaser life. The Style LL Tap Body is made in four sizes to cover a range of nominal pipe sizes from 1" to 12", inclusive.

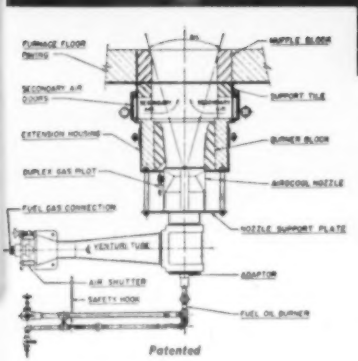
Write for Bulletin G-95

LANDIS MACHINE CO.
WAYNESBORO, PA., U. S. A.

NATIONAL AIROIL FUEL OIL - GAS BURNERS

for your *UP-FIRED* Petroleum Heaters, use . . .





Patented

OIL BURNERS and **GAS BURNERS** for industrial power, process and heating purposes; **STEAM ATOMIZING OIL BURNERS; MOTOR-DRIVEN ROTARY OIL BURNERS; MECHANICAL PRESSURE ATOMIZING OIL BURNERS; LOW AIR PRESSURE OIL BURNERS; GAS BURNERS; COMBINATION GAS and OIL BURNERS; AUTOMATIC OIL BURNERS,** for small process furnaces and heating plants; **FUEL OIL HEATERS; FUEL OIL PUMPING** and **HEATING UNITS; FURNACE RELIEF DOORS; AIR INTAKE DOORS; OBSERVATION PORTS; SPECIAL REFRACTORY SHAPES.**

"AIROCOOL" OIL-GAS TANDEM COMBUSTION UNITS

The above photo shows a group of four NATIONAL AIROIL TANDEM COMBUSTION UNITS, recently installed in a large Pennsylvania refinery. The burners are located at the Petro-Chem Furnace of the Vacuum Distillation Unit in this refinery. Although the installation was one of special application, "National Airoil" TANDEM UNITS very readily "fitted into the picture" with no trouble and a minimum of cost. This is because "AIROCOOL" TANDEM COMBUSTION UNITS are also designed for firing vertically upward, as shown, and are easily applied to all types of process furnaces.

The TANDEM UNIT maintains a high flame temperature with either fuel oil or gas; can be brought quickly to full capacity with a clean flame; and flame can be regulated and directed to uniformly radiate heat to the absorbing surfaces without flame impingement.

For complete details about the TANDEM COMBUSTION UNIT and the various types available, write

NATIONAL AIROIL BURNER CO., INC.

***Main Offices & Factory:* 1254 EAST SEDGLEY AVENUE, PHILADELPHIA 34, PA.**

Texas Office: 2512 South Boulevard, Houston 6

INDUSTRIAL OIL BURNERS, GAS BURNERS, FURNACE EQUIPMENT

COMPLETE "ON-CALL" STOCKS FOR YOUR SPECIALIZED METAL NEEDS

"One-call service... for on-call metals"

Geared to industry's continuous demand for specialized metals, Metal Goods' one-call service is designed to make your metal procurement easier — and more efficient. By having the metals you need "on-call" from your Metal Goods warehouse — *when* you need them — you can eliminate costly metal inventories... save storage space... reduce materials handling... and gain efficiency through simplifying your supply effort.

Metal Goods warehouses are strategically located to serve you quickly and dependably. Sheets, Plates, Tubes, Bars, Fittings and Accessories of... **STAINLESS STEELS ALUMINUM • BRASS • COPPER • MONEL* • NICKEL* • INCONEL***

Plus... complete stocks of Condenser and Heat Exchanger Tubes... Admiralty... "Alclad" Aluminum... 70/30 Super-Nickel, Monel.

Tube Sheets... Naval Brass... Muntz Metal

Fittings and Accessories

Consult your Metal Goods metallurgical specialist on the proper metal for your application.

**Not warehoused in Kansas City or St. Louis*

Phone, wire or write your Metal Goods warehouse for your specialized metal needs.

Do you have the "Metalog"? It's a complete stock list and metal manual — Write for it!

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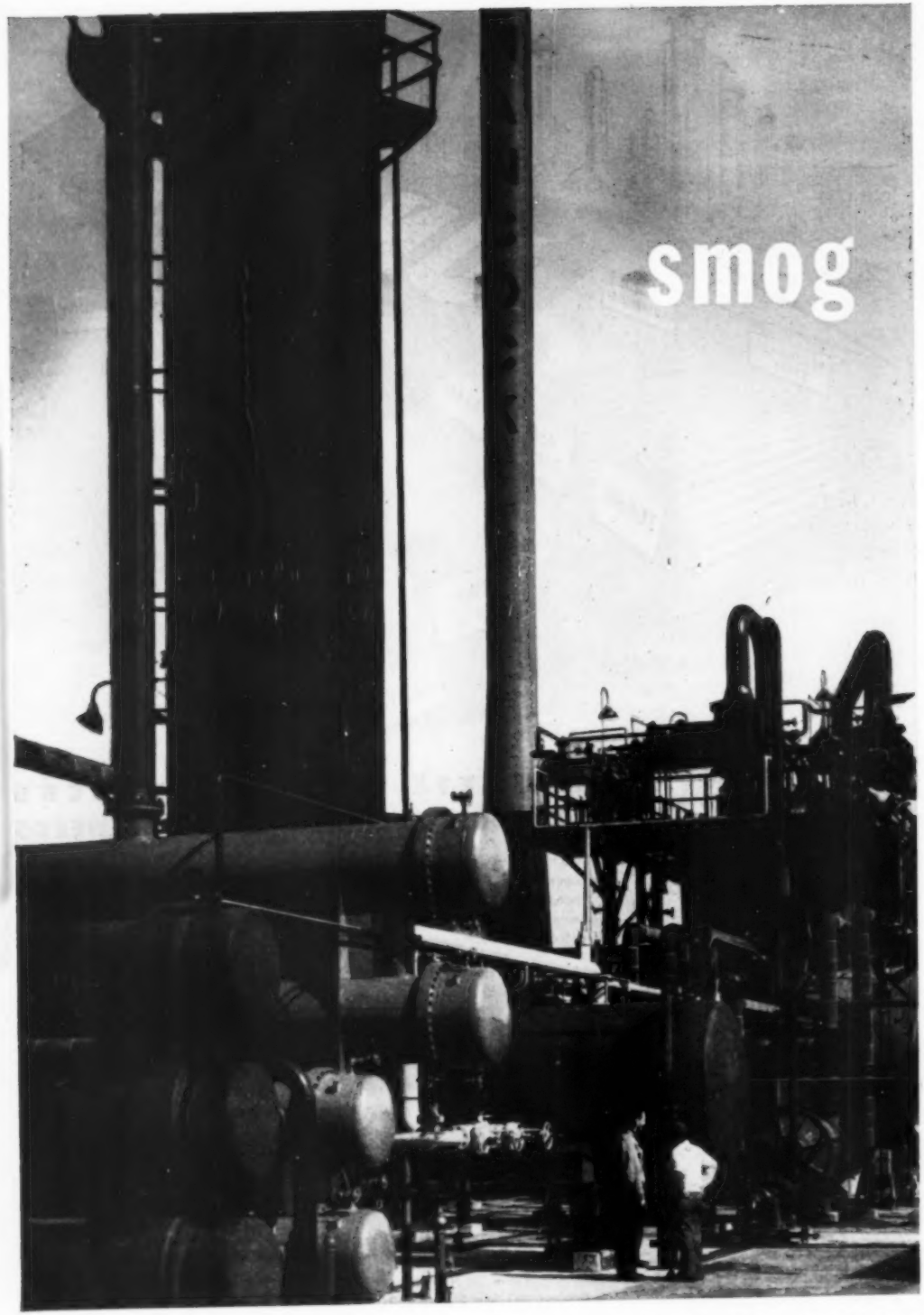
METAL GOODS CORPORATION

OFFICES AND WAREHOUSES: **St. Louis, 5206 Brown Ave. • Tulsa, 302 N. Boston • Dallas, 6211 Cedar Springs Road • Houston, 711 Milby St. • New Orleans, 432 Julia St. • Denver, 8117 17th St. • Kansas City, 1300 Burlington**


smog

Eliminating at a profit

Pictured here is what we believe to be the first plant attacking the problem of atmospheric contamination by sulfur-bearing gases logically, effectively and profitably.

Hancock Chemical Company receives hydrogen sulfide removed from the fuel gases of nearby oil refineries and converts it to elemental sulfur which is sold for the manufacture of sulfuric acid.

The refiners benefit by the elimination of noxious fumes from stack gases, thereby improving maintenance and operation efficiency, and by the reduction of corrosion.

The return from the sale of the sulfur provides an attractive return on the plant investment.

The community benefits by the removal of many *tons a day* of sulfur from the atmosphere.

Initial operations of this plant have been so successful that plans are now being made for doubling the capacity of the installation.

Operating and investment cost data for plants of this type may be readily obtained from any Badger office.

E. B. BADGER & SONS CO. · Est. 1841

A SUBSIDIARY OF STONE & WEBSTER, INC.

BOSTON 14 · NEW YORK · SAN FRANCISCO · LOS ANGELES · LONDON

Process Engineers and Contractors for the Petroleum, Chemical and Petro-Chemical Industries

LOW COST ALCOA HEAT EXCHANGER TUBES CUT MAINTENANCE TIME!

Heat exchangers can be the weak link in your process chain. Retubing and off-stream time slice a big chunk from operating profits. This book tells how tube bundles of Alcoa Aluminum Tubes (A.S.T.M. Specification B234-48T) stave off replacements. They resist hydrocarbons, H_2S, carbon dioxide. Alcoa Alclad Tubes resist most cooling waters.

Priced at ½ the cost of Admiralty, ⅔ of cold-drawn seamless steel, ⅙ of stainless or Monel; they save both maintenance and first-cost dollars. Get all the facts from the booklet, "Alcoa Aluminum Heat Exchanger Tubes". It's free! Ask your Alcoa salesman or write ALUMINUM COMPANY OF AMERICA, 696 Gulf Building, Pittsburgh 19, Penna.

ALCOA ALUMINUM
HEAT EXCHANGER TUBES

ALCOA
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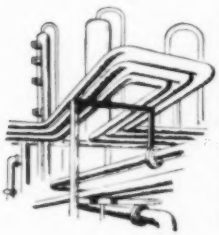
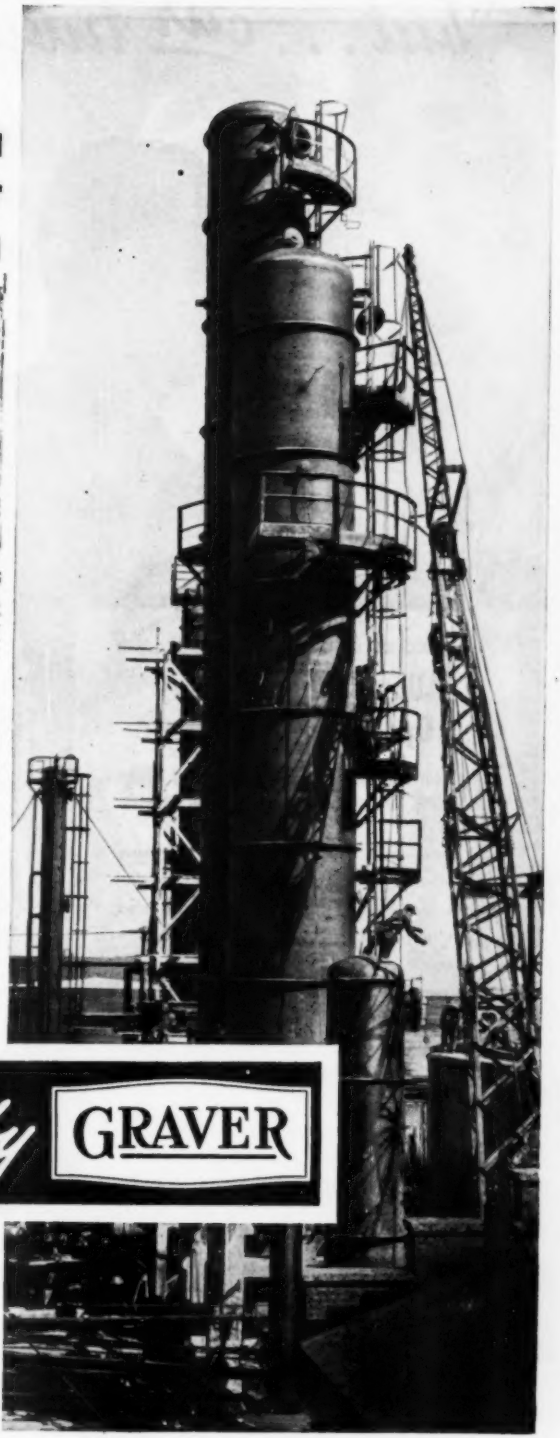
INCREASED PRODUCTION THROUGH PLANT EXPANSION

If plant expansion and modernization are necessary to boost your production, call Graver. This specialized division of the Graver company is geared to do the job . . . to serve the petroleum and process industries in all phases of engineering, procurement and erection of processing facilities.



Graver men and Graver equipment are available at strategic locations to bring the complete service to your construction project...whether it includes piping, masonry, equipment setting, electrical installations or erection of heavy vessels.

The facilities and experience of the Graver Construction Co. are available to you now. Write today for full information and quotations on your construction job.



Construction by GRAVER

GRAVER CONSTRUCTION CO.

A DIVISION OF

GRAVER TANK & MFG. CO., INC.

EAST CHICAGO, INDIANA

ENGINEERING DEPT.: 880 BERGEN AVENUE, JERSEY CITY, NEW JERSEY

NEW YORK PHILADELPHIA CHICAGO

"but... our tubing problem is DIFFERENT"

Probably Nothing Was Ever Truer. In Oil Refining There Are Perhaps Nearly as Many Tubing Problems as There Are Tubing Installations.

☆

To help solve your tubing problems, the technical staff of The Pressed Steel Co. offers you a wealth of experienced engineering assistance and production know-how, gained through the almost quarter-century we have been supplying welded alloy equipment to the refining industry. Send blue prints or write us to your needs.

PRESSED STEEL CO. WELDED TUBING IS

Alloy-Right for Every Operating Condition

We fabricate from the complete list of alloys, selecting the one that meets your problem.

Take any tubing assembly in your refinery. Obviously, if it were made of the one alloy that best meets the temperature, corrosion, pressure, abrasion, or oxidation problems involved, it would be subject to the least trouble and would show the best possible life/cost ratio. The Pressed Steel Co. enables you to enjoy these very real advantages, because we fabricate tubing from the complete list of alloys which are available today from any source. Tell us the operating conditions your tubing must face. We will then select the one alloy that best meets your specific requirements.

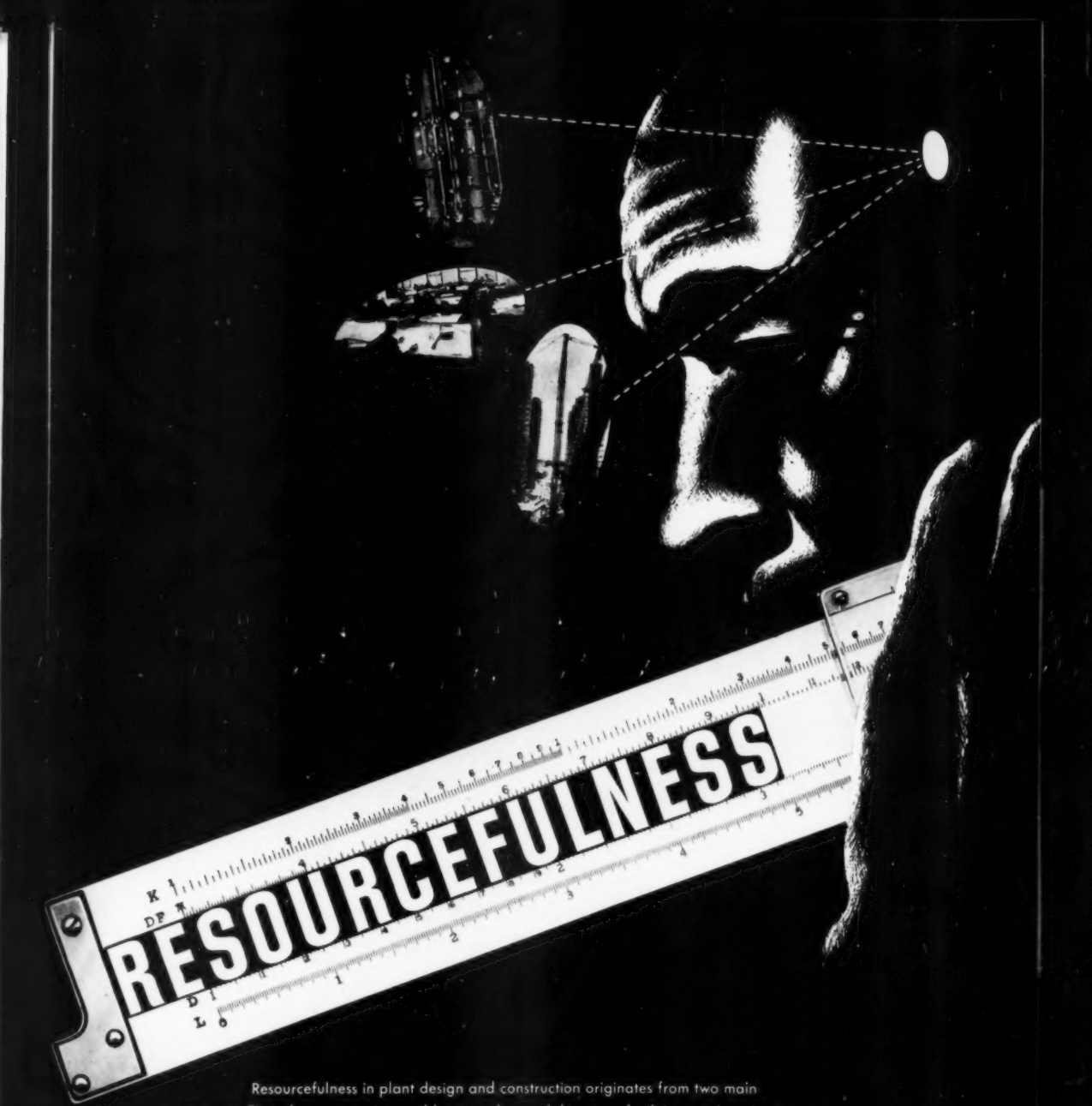
Diameters Up to 60"
Temperatures to 2200°F

'Pressed Steel' welded alloy tubing is furnished in standard and special sizes and shapes: any wall thickness from 1/16" to 5/16"; any diameter up to 60"; temperatures to 2200°F. It can be readily bent, coiled, swaged and formed; and butt-welded to make any required length. Chemical and physical perfection of 'Pressed Steel' tubing is assured by hydrostatic, tolerance, surface and straightness tests.

THE PRESSED STEEL COMPANY
of WILKES-BARRE, PENNSYLVANIA

Industrial Equipment of Heat and Corrosion Resistant WEIGHT-SAVING *Sheet Alloys*

☆ ☆ ☆ OFFICES IN PRINCIPAL CITIES ☆ ☆ ☆



Resourcefulness in plant design and construction originates from two main sources: First, the company's tangible strengths . . . laboratory facilities, engineering organization, manufacturing and construction equipment. Second, the capabilities of the *people* within the company organization in facing problems that require ingenuity and innovation.

These two company resources working together give maximum performance, for the resourceful man can accomplish no more than his tools and techniques permit.

Lummus offers you the resourcefulness that comes from complete facilities at the disposal of minds with originality and broad experience.

Economy
Fulfillment
Perspective
Teamwork

LUMMUS designs and builds with **RESOURCEFULNESS**
Technique

RESOURCEFULNESS in construction

Completion of this essential wartime plant faced a seemingly "unavoidable" delay:—the nation's entire shop capacity for tower and tank construction was already fully booked for equally essential work. Lummus met the emergency by building a complete pressure vessel shop on the site. Here, using modern time-saving methods such as automatic welding, towers and tanks for this and other vital war plants were fabricated on schedule.

RESOURCEFULNESS in planning

The problem here was to boost the capacity of a 10,000 B/D topping unit to 25,000 B/D without a serious break in output. By ingenious advance planning, the change-over was made with *only 72 hours downtime*. Nor was it just a "lucky accident"—for Lummus had assumed responsibility in its contract for this 72-hour time limit.

RESOURCEFULNESS in training

To erect this refinery in an isolated foreign location, local native labor was the only practical labor supply. Yet most of these people had never held a tool or even seen a welding torch. Lummus sent supervisors and foremen picked for their training aptitudes, backed them up with modern visual-education methods, organized a training school. "Graduates" were ready to meet erection schedules. Quality of workmanship met every test.

THE LUMMUS COMPANY
420 Lexington Avenue, New York 17, N. Y.

LUMMUS

CHICAGO—600 South Michigan Avenue, Chicago 5, Ill.
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The Lummus Company, Ltd., 525 Oxford St., London, W-1, England
Société Française des Techniques Lummus
39 Rue Cambon, Paris 1er, France
Compañía Anónima Venezolana Lummus—Edifico "Las Gradillas"
Esquina Las Gradillas, Caracas, Venezuela

Never Before a Valve Like This!

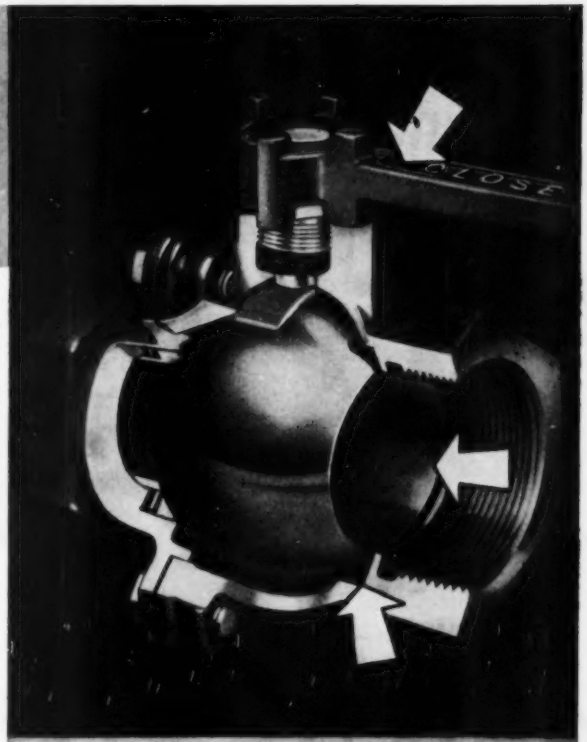
- INCREASES PROFITS
- REDUCES MAINTENANCE COST

The Rockwood Ball Type Valve has already made, in various types of industries, an outstanding record for longer, dependable, efficient performance.

Three *chief* reasons for the amazing Rockwood Valve record is the leak proof service, full *round* flow, and quick opening and closing. These remarkable engineering features will give efficient and economical operation through years of everyday use. Together, they help increase your profits and reduce your maintenance cost.

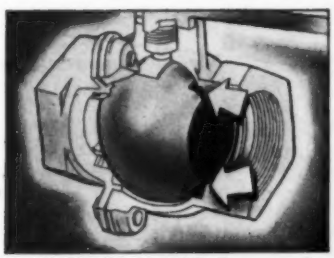
It's time now to buy Rockwood Ball Type Valves. Distributors in all principal cities. Rockwood Valves are available in bronze from ½" to 2" for 300 p.s.i. working pressure. They are recommended for use on lines handling water, air, gas, petroleums, food, carbon dioxide, nitrogen and other gases, paraffin and asphalt base petroleums, also alcohol, paper fluids and many other types of liquids and gases.

WRITE TODAY FOR BULLETIN V-4

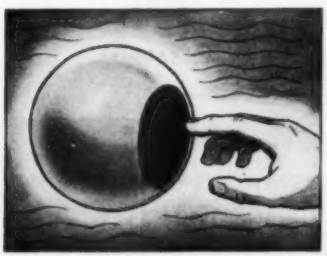


ROCKWOOD BALL TYPE VALVE

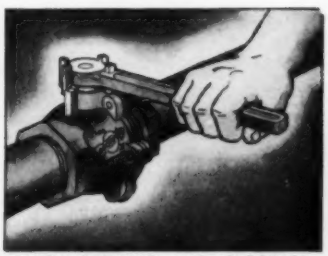
...You'll profit every day with these features!



LEAK PROOF SERVICE! Pressure of fluid stream automatically positions floating ball shut-off against new resilient synthetic rubber seat to form a *tight-seal* — stays tight!



FULL ROUND FLOW! Round opening in hard chromium plated floating ball allows fluid stream to pass thru valve without creating turbulence — friction loss is reduced to a minimum.



QUICK OPENING AND CLOSING! By a quarter turn (¼) movement of handle, valve is easily opened and closed under full pressure. Design of handle allows valve to be installed in any position.

ROCKWOOD SPRINKLER CO

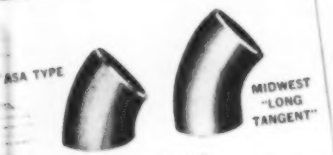
102 HARLOW STREET WORCESTER 5, MASS

IMPROVE PIPING DESIGN and REDUCE COSTS with . . . MIDWEST WELDING FITTINGS

90° ELBOWS

REDUCING ELBOWS

TEES



45° ELBOWS

180° RETURNS

LAP-JOINT STUB ENDS

LATERALS
CROSSES
REDUCING-ON-RUN TEES

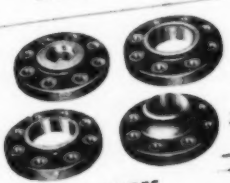
REDUCERS

SLEEVES

CAPS

SADDLES

SHAPED NIPPLES



FLANGES

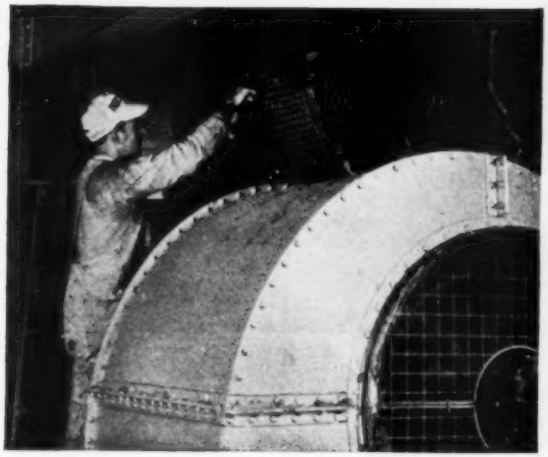
To simplify and improve piping design, Midwest originated and developed many of the fittings shown here. For example: the Midwest Reducing Elbow (available in sizes including 12") decreases turbulence and pressure drop when used instead of a standard elbow and a reducer; more than one third of the welding is also saved. Midwest Long Tangent Elbows save pipe and time in lining up. Midwest Saddles compensate for weakening of header body resulting from metal removed for nozzle opening. Midwest Welding Fittings stocks are carried in all principal cities . . . get in touch with your distributor.

MIDWEST PIPING AND SUPPLY COMPANY, Inc.

Main Offices: 1450 South Second Street, St. Louis (4), Mo.

Sales Offices: New York (7), 30 Church St.

Chicago (3), 79 West Monroe St. • Los Angeles (33), 520 Anderson St. • Houston (2), 229 Shell Bldg. Tulsa (3), 533 Mayo Bldg. • South Boston (27), 426 First St. • Distributors in Principal Cities.



Temperature control demands **EAGLE-PICHER** *Insulations*

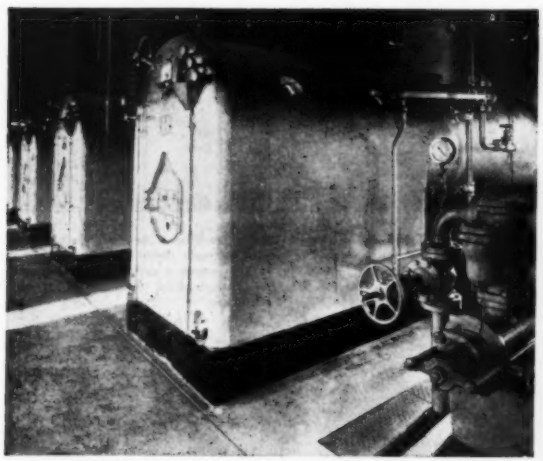
Eagle-Picher Super "66" Insulating Cement

has unique "Springy Ball" Structure!

"Springy Ball" pellets of Eagle-Picher Mineral Wool give Super "66" tremendous insulating efficiency. Each pellet contains heat-saving dead air cells that remain after the insulation dries to preserve extremely low thermal conductivity. In addition, Super "66" actively inhibits rust on metal equipment. It's all-purpose, sticks to any shape surface, and withstands temperatures up to 1800 F. Complete technical and application data on request.

Let these Eagle-Picher products also save you money... power... time

Insulating Felts
Supertemp Block • Blankets
Loose Wool • Pipe Covering
Stalastic • Insulseal • Insulstic
Swetchek • Finishing Cements
Insulating Cements



EAGLE-PICHER INSULATIONS for

EAGLE EP PICHER

High and low temperature

Since 1843
THE EAGLE-PICHER COMPANY
CINCINNATI (1), OHIO

PETROLEUM EQUIPMENT

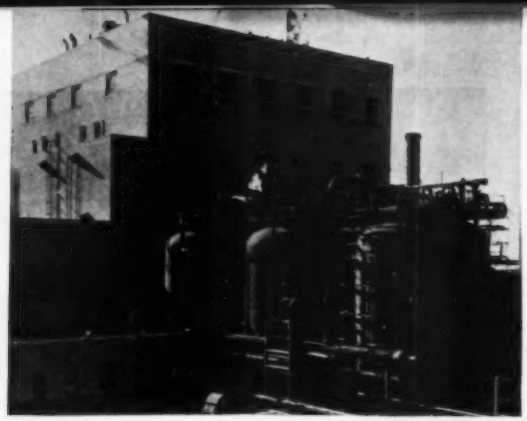
"Buying Guide"

FOR FIELD, REFINERY, TRANSPORTATION

Need help for *new building — modernizing — expanding?* Get *practical, down-to-earth* buying assistance from Allis-Chalmers oil industry specialists, who *know* petroleum equipment needs!

And be *assured* of *unbiased recommendation* because you choose from the world's *widest range* of electric power and mechanical processing equipment!

A-C specialists are as near as your phone. Call your A-C Office or write ALLIS-CHALMERS, MILWAUKEE 1, WIS.



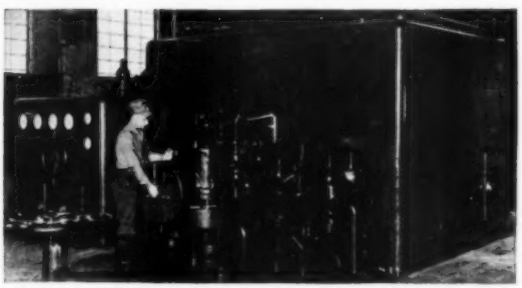
Operation of Large Hot Process Units for Silica Control

AUTOMATIC proportioners release chemicals according to the inflow of raw water as measured by orifice-type meters. Agitators in the chemical and sedimentation tanks assure a thorough mixture.

Raw water is first treated in the lime-soda unit to reduce silica content and hardness to a specified value. Then the phosphate unit reduces the hardness to zero. Pressure filters clarify the effluent. Facilities for sludge recirculation and for backwashing the filtering medium are also included.

When extended, this Allis-Chalmers hot process system will consist of six sedimentation tanks, twenty-four filter tanks, and allied mixing tanks, proportioners and control.

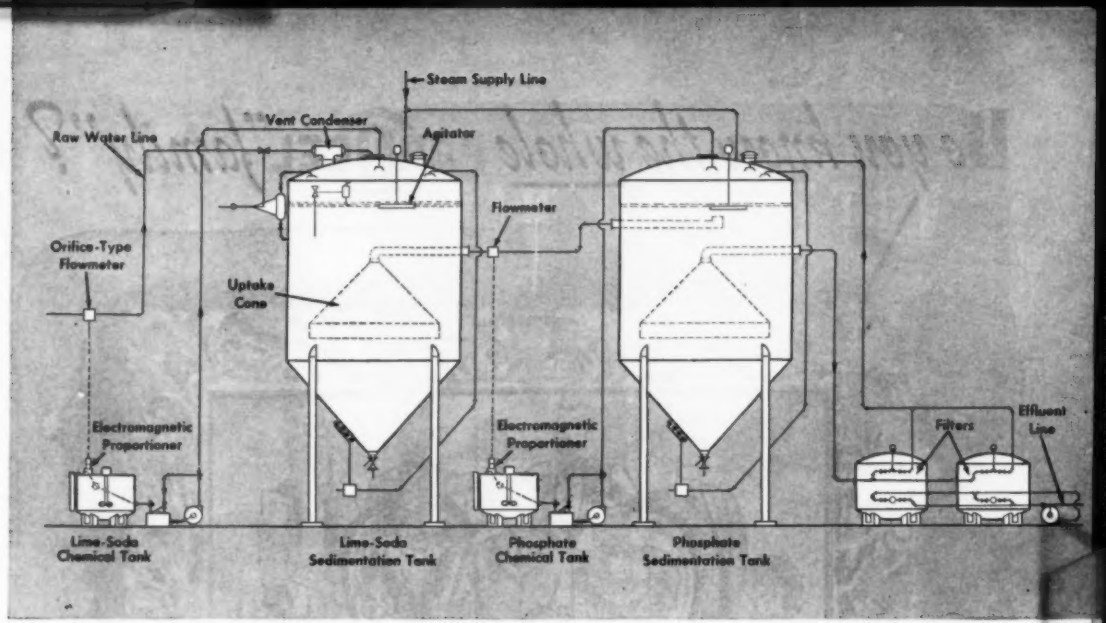
CENTRAL PANEL contains control for all chemical proportioning and feeding mechanisms and pumps, flow recorders, pressure gauges, and other necessary instruments.



This 10,000-KW Allis-Chalmers topping turbine is one of the units on the down side of the boilers. The turbine exhausts steam at 450 psig to a series of smaller turbines. In this way a high pressure system is superimposed on a previously installed low pressure superimposed system to supply electric power and steam throughout the refinery.

ALLIS-

Power, Electrical, Processing,



Allis-Chalmers Water Conditioning Treats 100% Makeup for Three 1350-psig, 900-degree Boilers!

THIRD UNIT ON ORDER FOR LARGE REFINERY WILL INCREASE CAPACITY FROM 160,000 TO 240,000 GALLONS PER HOUR!

AT THIS MIDWEST refinery raw water is treated for what are perhaps the *severest* boiler conditions in the petroleum industry.

Before the feedwater enters the boilers, Allis-Chalmers hot lime-soda and phosphate units reduce hardness to zero and silica content to considerably less than 1 ppm to prevent scale formation in boiler tubes and silica deposits on turbine blading.

At this refinery, Allis-Chalmers has proved its ability to solve the toughest water conditioning problems in the petroleum industry by providing a system that automatically maintains the desired feedwater properties within safe limits.

Let Allis-Chalmers go over your water conditioning needs with you. Check at right how Allis-Chalmers is equipped to supply *unbiased* recommendations for a sound system to solve water treatment problems. Call your nearby A-C sales office for qualified water conditioning advice. Or write direct.

A-2688

ALLIS-CHALMERS, 1062A SO. 70 ST.
MILWAUKEE, WIS.

FOR UNBIASED RECOMMENDATIONS, CHECK A-C WATER CONDITIONING:

SERVICE includes complete analysis of water supplies; reports on water-steam cycle; study of present equipment; advice on selection of chemicals; periodic reports and service calls.

CHEMICALS — Scale inhibitors for all heat exchange cycles. Special chemicals to prevent boiler scale, control corrosion, reduce silica, and correctly condition sludge.

EQUIPMENT Hot and cold process softeners; sodium and hydrogen zeolite softeners; degasifiers; deionizers; chemical proportioners; oil removal and water filters.

Get the Complete Story —
ASK FOR DESCRIPTIVE BULLETINS!

CHALMERS

and General Machinery for the Petroleum Industry

A-C ALLIS-CHALMERS

Do you know the whole POROCEL "family"?

It's a *large* "family" of high-grade activated bauxites—well worth knowing if you're looking for:

1. A highly selective adsorbent for removal of colors, odors, tastes, sulfur, acids, fluorides, etc., from process liquids or gases.
2. A rugged carrier having adsorptive properties for use as a catalyst support.
3. A high-surface-area catalyst for desulfurization and reforming systems.
4. An inexpensive desiccant for drying air, hydrogen, CO_2, organic liquids and gases.

We've perfected various pre-treatments to alter our basic material for different uses. We know how to apply Porocel to cut costs and improve petroleum products. And, we have sources and facilities which insure prompt supply of uniform material.

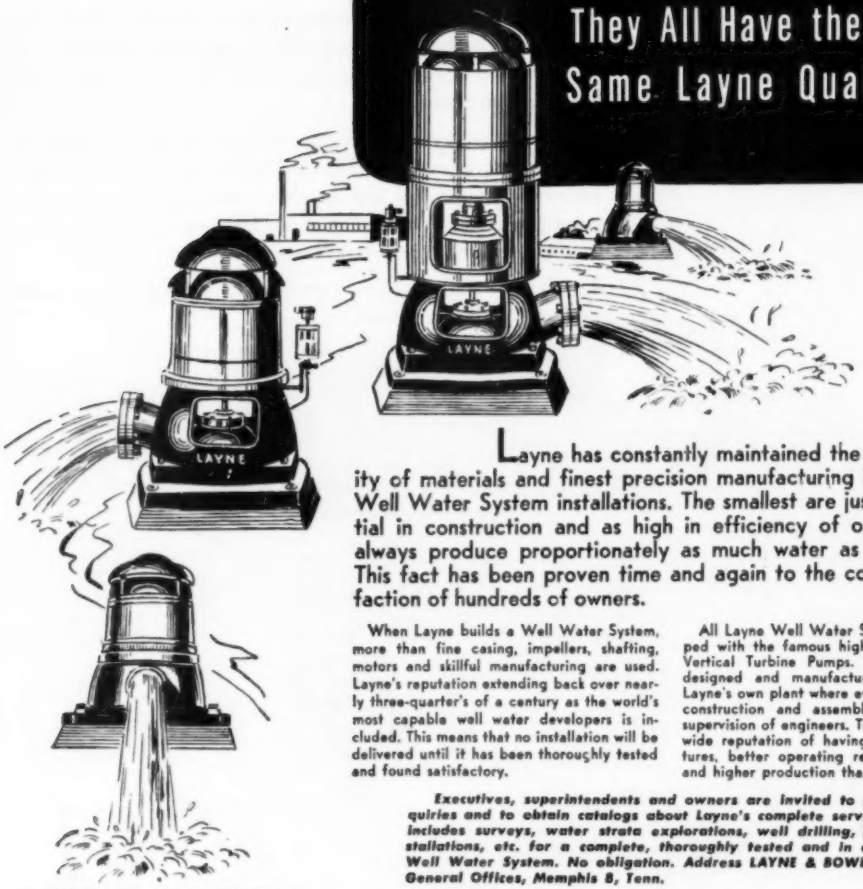
May we introduce you to the Porocel that's "engineered" to your specific needs? Attapulgus Clay Company (Exclusive Sales Agent) Dept. W, 210 West Washington Square, Philadelphia 5, Pa.

POROCEL CORPORATION

ACTIVATED BAUXITES • SUPPORTED CATALYSTS • CATALYST CARRIERS • ADSORBENTS AND DESICCANTS

BIG OR LITTLE

They All Have the Same Layne Quality



Layne has constantly maintained the highest quality of materials and finest precision manufacturing in all of their Well Water System installations. The smallest are just as substantial in construction and as high in efficiency of operation and always produce proportionately as much water as the biggest. This fact has been proven time and again to the complete satisfaction of hundreds of owners.

When Layne builds a Well Water System, more than fine casing, impellers, shafting, motors and skillful manufacturing are used. Layne's reputation extending back over nearly three-quarter's of a century as the world's most capable well water developers is included. This means that no installation will be delivered until it has been thoroughly tested and found satisfactory.

All Layne Well Water Systems are equipped with the famous high efficiency Layne Vertical Turbine Pumps. These pumps are designed and manufactured exclusively in Layne's own plant where every detail of their construction and assembling is under the supervision of engineers. They enjoy a world-wide reputation of having more good features, better operating records, longer life and higher production than any other made.

Executives, superintendents and owners are invited to make inquiries and to obtain catalogs about Layne's complete service which includes surveys, water strata explorations, well drilling, pump installations, etc. for a complete, thoroughly tested and in operation Well Water System. No obligation. Address LAYNE & BOWLER, INC., General Offices, Memphis 8, Tenn.

VERTICAL TURBINE PUMPS

Layne Vertical Turbine Pumps are available in sizes from 40 to 16,000 gallons of water per minute. These pumps, as a rule, can be installed in wells already drilled, thus gaining higher production without heavy expenditures. Write for pump catalog.

LAYNE
WELL WATER SYSTEMS

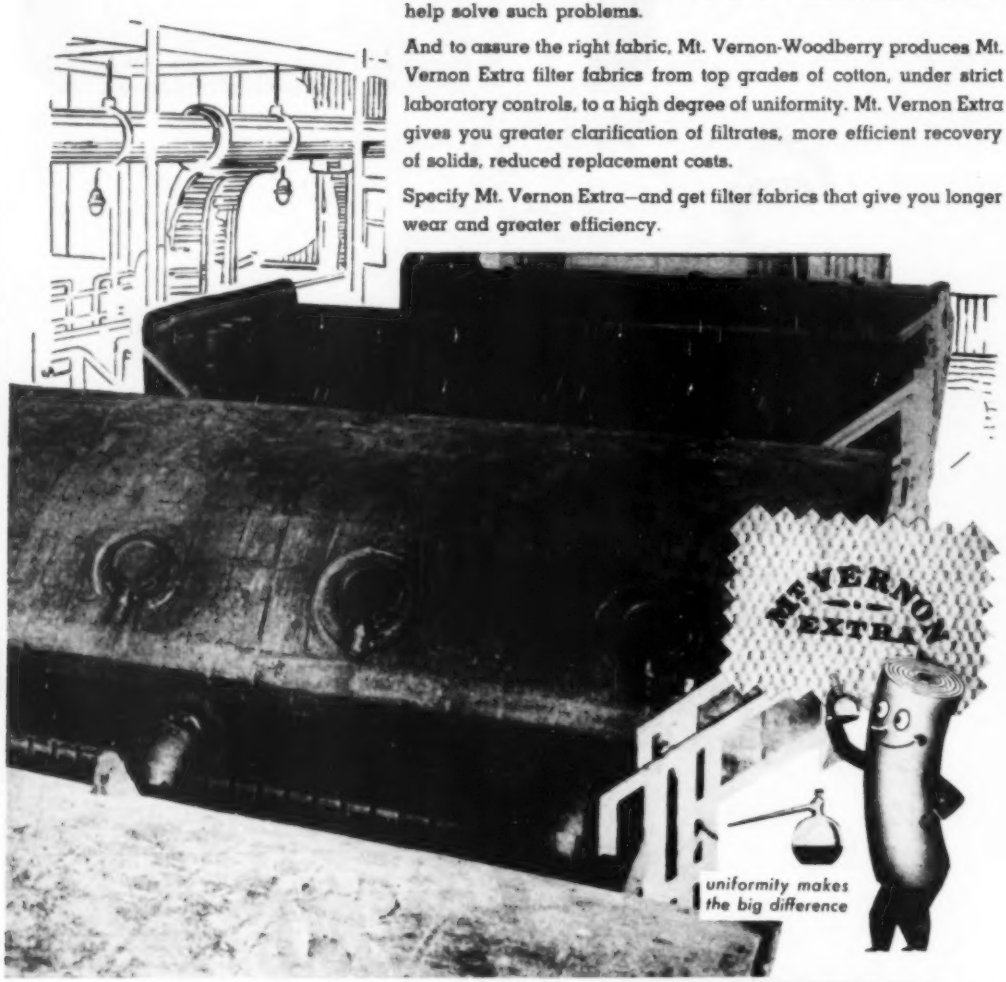
AFFILIATED COMPANIES—Layne-Arkansas Co., Stuttgart, Ark. ★ Layne-Atlantic Co., Norfolk, Va. ★ Layne-Central Co., Memphis, Tenn. ★ Layne-Northern Co., Mishawaka Ind. ★ Layne-Louisiana Co., Lake Charles, La. ★ Louisiana Well Co., Monroe, La. ★ Layne-New York Co., New York City ★ Layne-Northwest Co., Milwaukee, Wis. ★ Layne-Ohio Co., Columbus, Ohio ★ Layne-Pacific, Inc., Seattle, Wash. ★ Layne-Texas Co., Houston, Tex. ★ Layne-Western Co., Kansas City, Mo. ★ Layne Minnesota Co., Minneapolis, Minn. ★ International Water Corp., Pittsburgh, Pa. ★ International Water Supply, Ltd., London, Ont. ★ Layne-Hispano Americana, S.A., Mexico, D.F.

Filter Fabrics that Fill the Bill ...Mt. Vernon Extra

There are few filtering problems that won't yield to a sound engineering approach and the right fabric. One of the functions of the laboratories and engineering staff of Mt. Vernon-Woodberry is to help solve such problems.

And to assure the right fabric, Mt. Vernon-Woodberry produces Mt. Vernon Extra filter fabrics from top grades of cotton, under strict laboratory controls, to a high degree of uniformity. Mt. Vernon Extra gives you greater clarification of filtrates, more efficient recovery of solids, reduced replacement costs.

Specify Mt. Vernon Extra—and get filter fabrics that give you longer wear and greater efficiency.



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MARLEY ANNOUNCES NEW DriCooler*

Cooling Tower Manufacturer Supplements Line With Finned-Tube Dry Surface Cooling Equipment

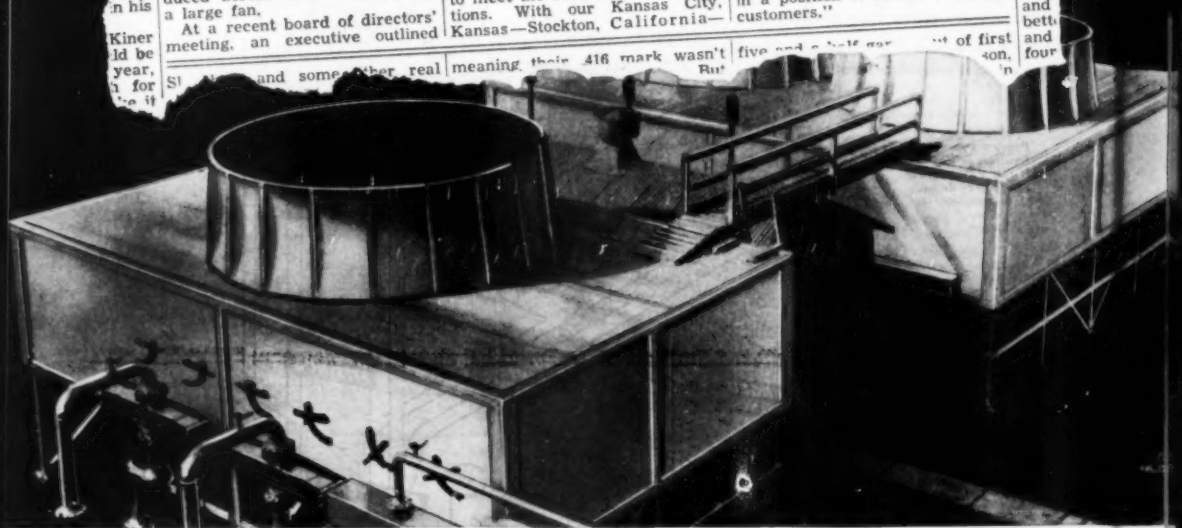
Kansas City, Kans., April 3.—The Marley Company, Inc., manufacturers of water cooling products, have announced that they are introducing a new product, the DriCooler.

Company officials said that The Marley Company has been manufacturing similar finned-tube dry surface cooling equipment for another company for some time. This equipment cools fluids by circulating them through finned tubes while air is forced or induced across their surface with a large fan.

At a recent board of directors' meeting, an executive outlined the company's position. "Our fans, drive shafts, Geareducers, and fan cylinders, which have proved so successful on our water cooling towers, are used on the DriCooler. Framing, either wood or metal, is also similar to that used in cooling tower design. We have developed something new, a sheet asbestos covered redwood frame that requires little maintenance, even in very corrosive atmospheres.

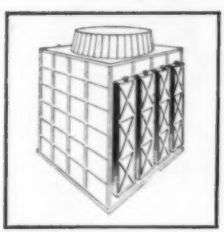
"For the present we will alter our three basic DriCooler designs to meet the customers' specifications. With our Kansas City, Kansas—Stockton, California—Louisville, Kentucky, plants now in operation, we have the flexibility to turn out special as well as standard designs. All parts of the DriCooler are designed and manufactured by us except the heat transfer surface which is made to Marley's specification.

"Although water cooling towers and DriCoolers have individual applications, the fields often overlap and a thorough evaluation must be made of both types of equipment to determine which is more economical. Since we make both kinds of equipment, we are in a position to better serve our customers."

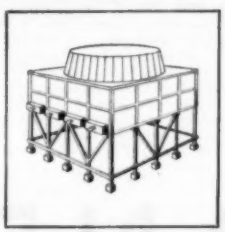


3 BASIC DRICOOLER DESIGNS ... Available in Sheet Asbestos Covered Redwood or Steel

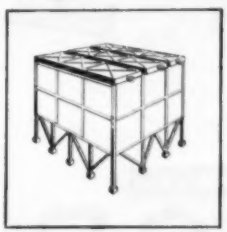
No matter what your cooling needs may be, MARLEY DriCoolers or Cooling Towers will do the job. Ask for a Marley Trained Application Engineer to help you analyze your requirements and recommend the equipment best suited to your purpose. No cost or obligation.



1. Induced Draft vertical or horizontal heat transfer surface on two sides.



2. Induced Draft horizontal heat transfer surface under the fan.



3. Forced Draft horizontal heat transfer surface over the fan.

*DriCooler is the exclusive trademark of The Marley Co., Inc., and is used to designate its finned tube dry cooling equipment.

MARLEY COOLING TOWERS

THE MARLEY COMPANY, INC. • KANSAS CITY 15, KANSAS

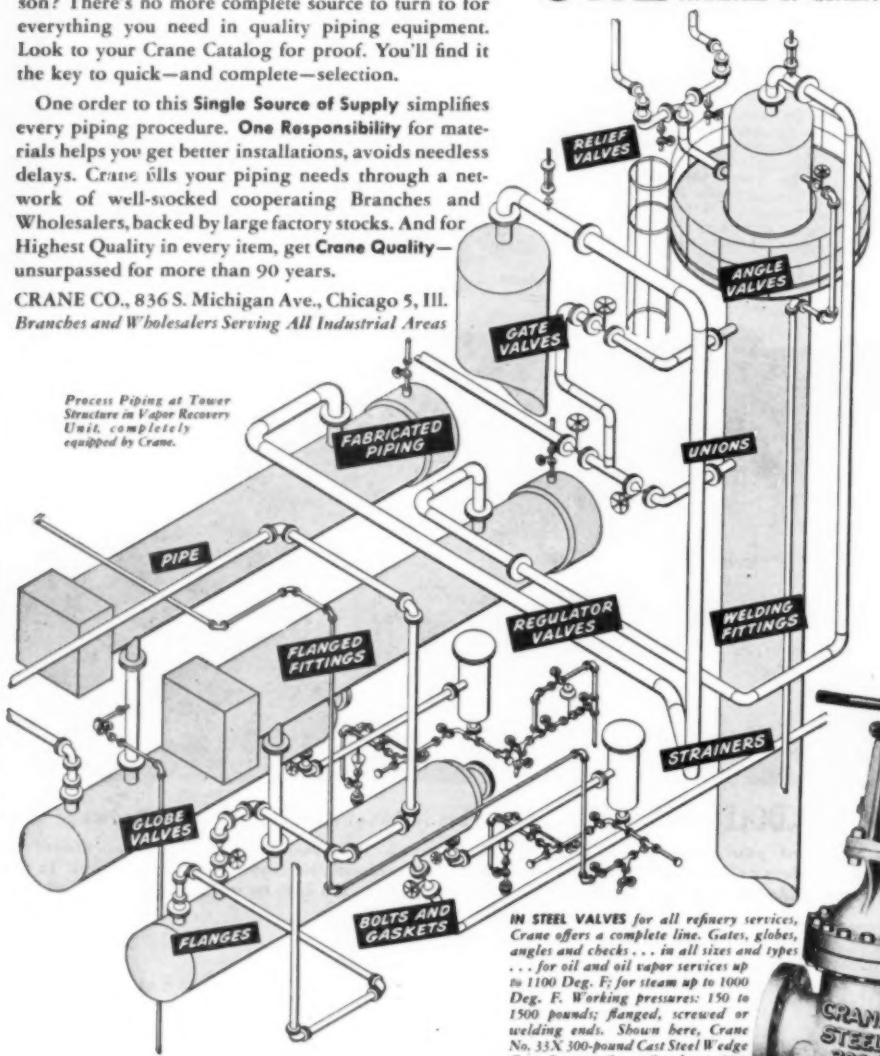
You name it...CRANE supplies it ...Everything in refinery piping

Take This Vapor Recovery Process Piping, for example. Throughout this maze of valves, fittings, pipe and accessories, one name stands out—CRANE. The reason? There's no more complete source to turn to for everything you need in quality piping equipment. Look to your Crane Catalog for proof. You'll find it the key to quick—and complete—selection.

One order to this **Single Source of Supply** simplifies every piping procedure. **One Responsibility** for materials helps you get better installations, avoids needless delays. Crane fills your piping needs through a network of well-stocked cooperating Branches and Wholesalers, backed by large factory stocks. And for Highest Quality in every item, get **Crane Quality**—unsurpassed for more than 90 years.

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas

ONE SOURCE OF SUPPLY
RESPONSIBILITY
STANDARD OF QUALITY



Process Piping at Tower Structure in Vapor Recovery Unit, completely equipped by Crane.

IN STEEL VALVES *for all refinery services, Crane offers a complete line. Gates, globes, angles and checks . . . in all sizes and types . . . for oil and oil vapor services up to 1100 Deg. F; for steam up to 1000 Deg. F. Working pressures: 150 to 1500 pounds; flanged, screwed or welding ends. Shown here, Crane No. 33X 300-pound Cast Steel Wedge Gate. See your Crane Catalog, p. 304.*

EVERYTHING FROM . . .

VALVES · FITTINGS
PIPE · PLUMBING
AND HEATING

CRANE

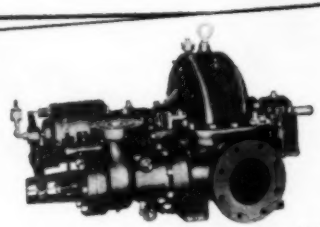
FOR EVERY PIPING SYSTEM

5 Ways

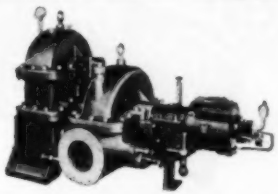
TO MAKE YOUR STEAM DO MORE WORK...

Power-Saving Worthington Turbines Cut The Operating Costs Of Mechanical Drives

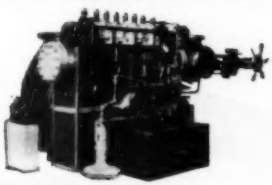
Worthington Turbines are built in all sizes and types — including straight condensing, straight non-condensing, extraction, mixed pressure extraction, low pressure and high back pressure — to meet the widest range of requirements. Steam or gas driven, for mechanical or generator drive, all are available with governors for constant or variable speeds. If desired, control devices can be incorporated in the governor.



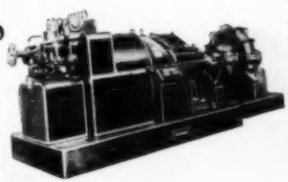
Single Stage. Sizes up to 1500 hp. Particularly adapted for driving all types of pumps, fans, small blowers and other auxiliaries where simplicity of construction and reliability are of prime importance.



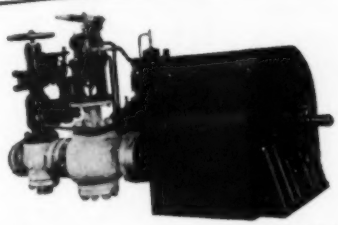
Single Stage With Integral Reduction Gear. Sizes up to 200 hp. A compact, sturdy, dependable unit with economical turbine operation. Especially suited for driving slow or moderate speed auxiliaries at low steam consumption.



Multi-Stage. Sizes up to 20,000 hp, and all types. Longer blade-life and more economical than single stage turbines especially on larger horsepowers and at slow or moderate speeds. Suitable for all kinds of pumps, blowers, compressors and other mechanical drives.



Multi-Stage With Separate Gear. Like all Worthington Multi-Stage Turbines, these are available in all types and are readily adaptable to special applications. Recommended for driving low speed equipment such as condenser circulating pumps, water supply pumps, etc.



High Back Pressure. Can be supplied in either single or multi-stage type for exhaust pressures up to 250 lbs.

For Low-Cost, Dependable Power. Check fully on the many advantages of Worthington Turbines. You'll discover what users the world over already know — that *there's more worth in Worthington.* Contact your nearest Worthington representative or district office, or write direct to *Worthington Pump and Machinery Corporation, Steam Turbine Division, Wellsville, N. Y.*

WORTHINGTON

Steam Turbines

T9-3

A GREAT TEAM IN STEAM

Feed Water Heaters

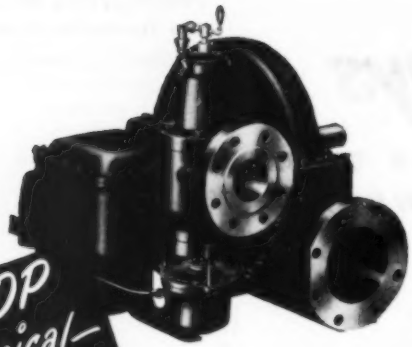
Multi-Stage Turbines

Boiler Feed Pumps

Turbine-Generator Sets

Single-Stage Turbines

Surface Condensers



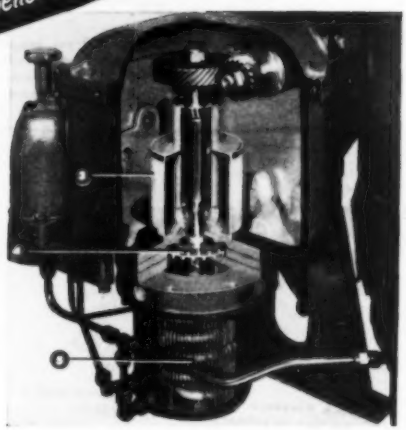
Type DP Mechanical-Drive Turbine

LOOK AT THESE

Better Governing

1. **30% ADJUSTABLE SPEED RANGE** is wider than obtainable with mechanical governors.
2. **RELIABILITY** even after long standby assured by totally enclosed, continuously lubricated hydraulic governor.

Better Lubrication



3. **CLEAN OIL** maintained by bronze mesh oil strainer.
4. **POSITIVE PRESSURE** furnished by turbine-type oil pump.
5. **ADEQUATE OIL COOLING** provided by high-capacity fin-tube oil cooler.

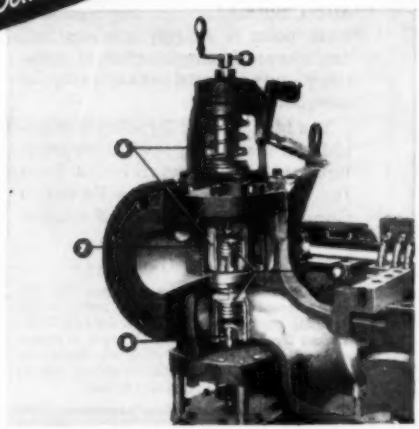
SPECIAL FEATURES

—AT NO EXTRA COST

YOU get a host of special features in the Type DP line of mechanical-drive turbines—features which provide better governing, lubrication, valving, and less maintenance than previous standard units. These features, formerly obtainable only on costlier "special" machines, are standard on the DP—at no extra cost.

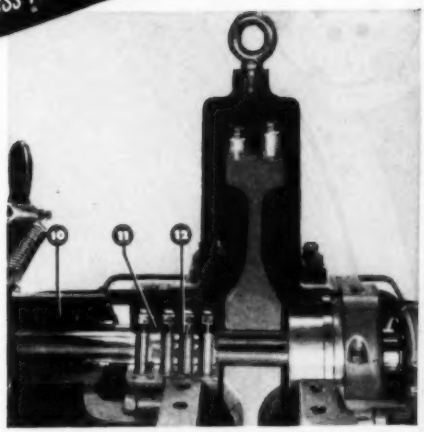
If you have a turbine application, be sure to investigate the time and trouble-saving features of the DP. Your G-E representative will be glad to give you all the facts. Apparatus Department, General Electric Company, Schenectady 5, New York.

Better Valving



6. COST OF SEPARATE SHUT-OFF VALVE often saved by combined trip-throttle valve.
7. LONG LASTING heavy Monel steam strainer.
8. MAINTENANCE REDUCED by valve stem sealing bushings —no soft packings required.
9. EASY ONE-HAND OPERATION with balanced valve design.

Less Maintenance



10. LONG BEARING LIFE assured by solid-backed bearings.
11. SHAFT EROSION PREVENTED by Monel spray under packings.
12. STEAM LEAKAGE sealed off by heavy double-seal carbon packings.

GENERAL ELECTRIC

AT LAST! 6-Point Recording on a Single Round Chart

Employing only one measuring system, the new Foxboro Multi-Record Dynalog gives up to 6 clean-cut records in as many different colors on one convenient *round* chart. The ingenious, foolproof switching arrangement provides recordings in sequence every 6 seconds—so close that the record of each measurement appears as a continuous line. The record colors positively will not run together.

Like all Dynalog Electronic Instruments, balancing from any measurement point is entirely *stepless* and continuous. Its combination of accuracy, speed and sensitivity is unequalled.

The Multi-Record Dynalog is available for measuring several temperatures or other process variables. Send for Bulletin 428. **The Foxboro Company, 74 Neponset Avenue, Foxboro, Mass., U. S. A.**

UNIQUE ADVANTAGES!

1. Round Chart simplifies operations. You can check records faster, easier and better on the familiar, compact round chart of the new Multi-Record Dynalog. No yards of paper to insert, remove and spread out. Practically continuous lines to follow. Up to 6 distinct colors. Charts occupy less space . . . cost less to use.

2. Round Chart standardizes operations. You can order, stock and use the identical form of chart as used on other types of process instruments.

3. Multi-Record Dynalog saves space.

* Reg. U. S. Pat. Off.

Another FOXBORO FIRST

Reg. U. S. Pat. Off.

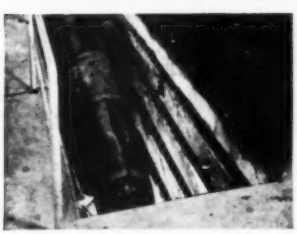
TUBE-TURN

WELDING FITTINGS AND FLANGES

18-inch standard weight Tube-Turn welding tee and pipe laid out preparatory to assembly for hydrostatic pressure test.

Welder completing last bead in assembly. Fitting and pipe now form homogeneous, leakproof unit.

Assembly is hung in pit, massively lined with concrete. During test top grating is closed and held down by a barricade of sandbags.



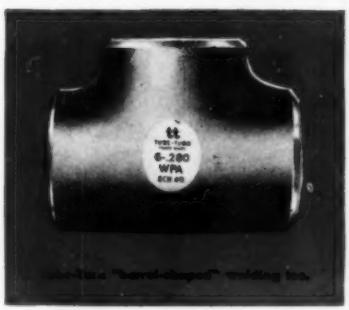
Final result after hydrostatic pressure test. The straight pipe burst first, and the tee is undamaged.

Strength through Design in Tube-Turn welding fittings

The pipe burst first!

Take an 18-inch standard weight welding tee. Take three corresponding lengths of pipe. Weld tee and pipe together. Cap the ends. Lower the assembly into a pit. Then apply hydrostatic pressure—much more than the assembly is supposed to take!

Something has to give! According to the accepted beliefs it should be the tee. But not in the case of the test pictured here. The Tube-Turn "barrel-shaped" tee was used—and the pipe burst, well before the tee was affected! Throughout numerous tests, this new type of tee has withstood at least 25 per cent more pressure than required by the formula given in ASA B16.9.



The superior strength of the tee was achieved without running up extra weight and cost, by carefully planned improvements in shape (based on the sphere, nature's strongest form for internal pressure), and by a carefully engineered distribution of metal.

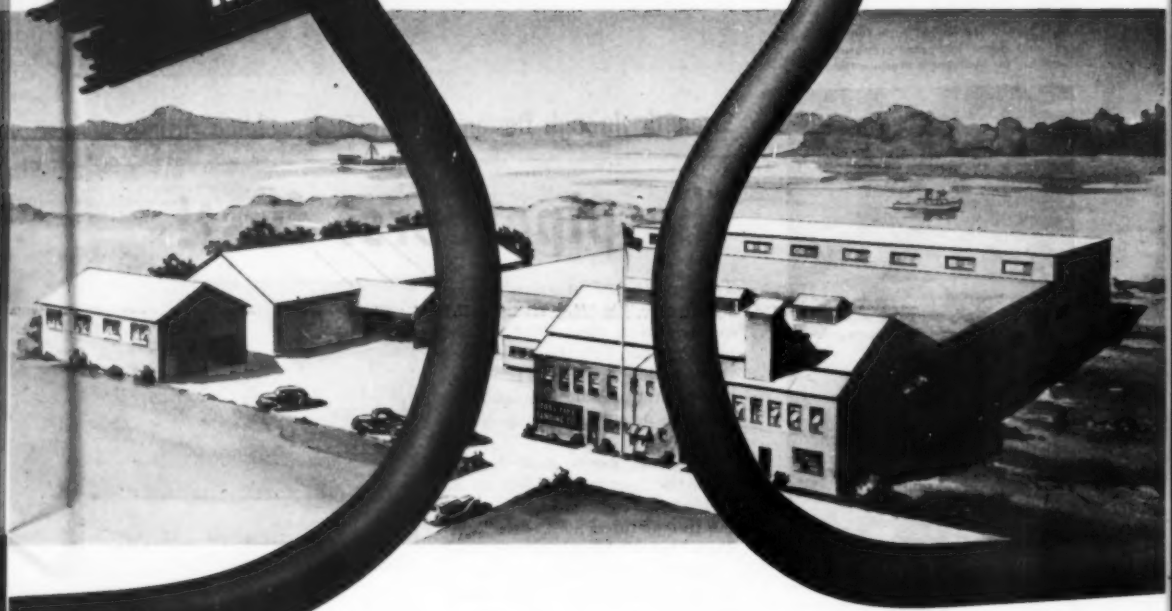
This is a typical example of *strength through design* in Tube-Turn welding fittings, and another good reason why leading piping engineers specify Tube-Turn equipped, welded piping.

TUBE TURNS, INC.

244 East Broadway, Dept. G, Louisville 1, Kentucky

District Offices at New York, Philadelphia, Pittsburgh, Chicago, Houston, Tulsa, San Francisco, Los Angeles

DEPENDABLE SERVICE ON PIPE BENDS AND PREFABRICATED PIPING



This modern plant manned by experienced personnel assures your getting dependable pipe bending and pipe fabricating service when promised.

39 YEARS EXPERIENCE SERVING LEADING COMPANIES... is the proof

TEXAS PIPE BENDING COMPANY

PIPE BENDS
PIPE COILS
WELDED HEADERS

Pipe Fabricators
HOUSTON TEXAS

OFFICE AND PLANT
301 FRIO STREET
WOODCREST-6-2659

The Easiest Way in the World to RACK TUBING!

There's a Unistrut Clamp for Every Tubing Need

use the "UNISTRUT" ALL-PURPOSE METAL FRAMING spring tubing clamp method

Eliminates Costly and Time-Consuming Means of Installation!

Install or remove clamp in a matter of seconds!

Press Clamp legs firmly between thumbs and forefingers

CHECK THESE ADVANTAGES

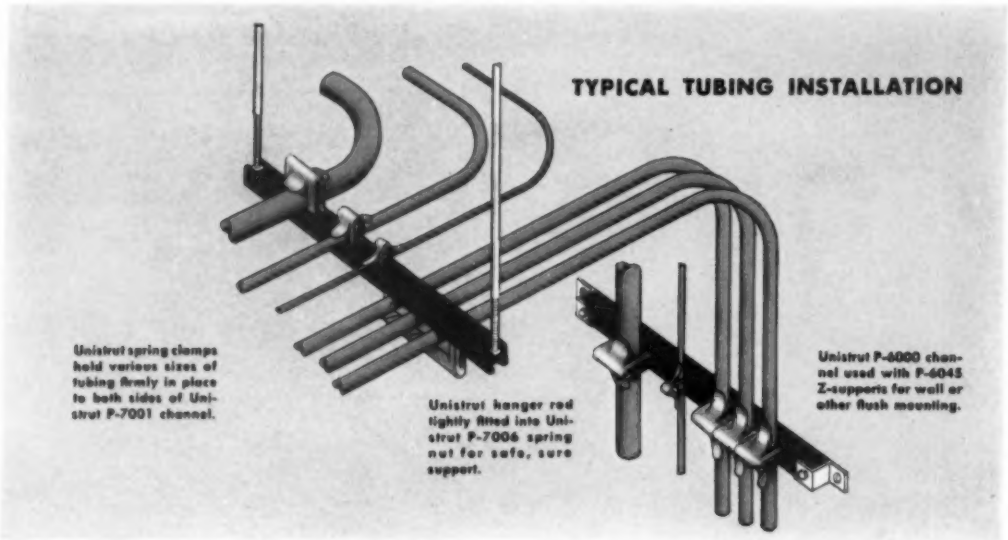
1. Clamp permits fastening of each tube individually, its respacing, relocation or removal.
2. Clamp allows expansion and contraction, yet holds tubing firmly in place.
3. Adjustment of clamps along channel for change in tube mounting position is fast and easy.
4. Clamps made to accommodate tubing from 3/16 inch to 1 inch OD.
5. Complete flexibility of installation—mount or hang tubing supports in *any* position.

ALL PURPOSE METAL FRAMING

UNISTRUT Products Company

1013 WEST WASHINGTON BOULEVARD
CHICAGO 7, ILL. • Phone MO 6-2665

Mount or hang tubing supports in any position


TYPICAL TUBING INSTALLATION
Unistrut spring clamps hold various sizes of tubing firmly in place to both sides of Unistrut P-7001 channel.
Unistrut hanger rod tightly fitted into Unistrut P-7006 spring nut for safe, sure support.
Unistrut P-6000 channel used with P-6045 Z-supports for wall or other flush mounting.

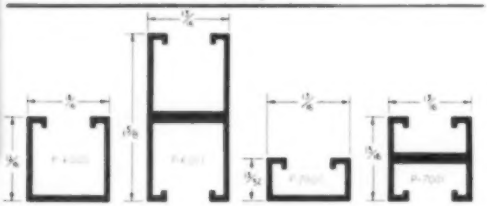
UNISTRUT CHANNEL DATA

P-6000 13/16" x 13/16"—19 gauge. Standard lengths 8 and 16 ft.

P-6001 13/16" x 1 5/8"—19 gauge, spot-welded back to back. Standard lengths 8 and 16 ft.

P-7000 13/16" x 13/16"—19 gauge. Standard length 10 ft.

P-7001 13/16" x 13/16"—19 gauge, spot-welded back to back. Standard length 10 ft.



Additional information and dimensions on spring clamps for tubing will be found on pages 23 and 24 in Unistrut Catalog No. 4.

Use for *all* tubing requirements—brass, copper, steel, glass, plastic, etc. Ideal for instrument piping and tubing installation.

Unistrut Clamps are designed to accommodate the following popular tubing sizes. Write for information on clamps for sizes other than those listed below:

CLAMP CATALOG NO.	TUBING OD
P-6101	3/16"
P-6102	1/4"
P-6104	3/8"
P-6106	1/2"
P-6108	5/8"
P-6110	3/4"
P-6112	7/8"
P-6114	1"

Check these other UNISTRUT uses:

Build all types of shelving, framing, supports, mounts, racks, pipe and cable hangers, fluorescent fixture supports, and many other structures quickly, easily and economically with only a hacksaw and wrench. No drilling or welding required.

FREE SAMPLES
SAMPLES OF THIS UNISTRUT CHANNEL, UNISTRUT TUBING CLAMP AND TUBING ARE AVAILABLE ON REQUEST

ALL PURPOSE METAL FRAMING

UNISTRUT Products Company

REPRESENTATIVES IN PRINCIPAL CITIES

1013 WEST WASHINGTON BLVD.
CHICAGO 7, ILL. • Phone MO 6-2665

U.S. PATENT NUMBERS

2327587 2329815
2345650 2363382
2380379 2405631

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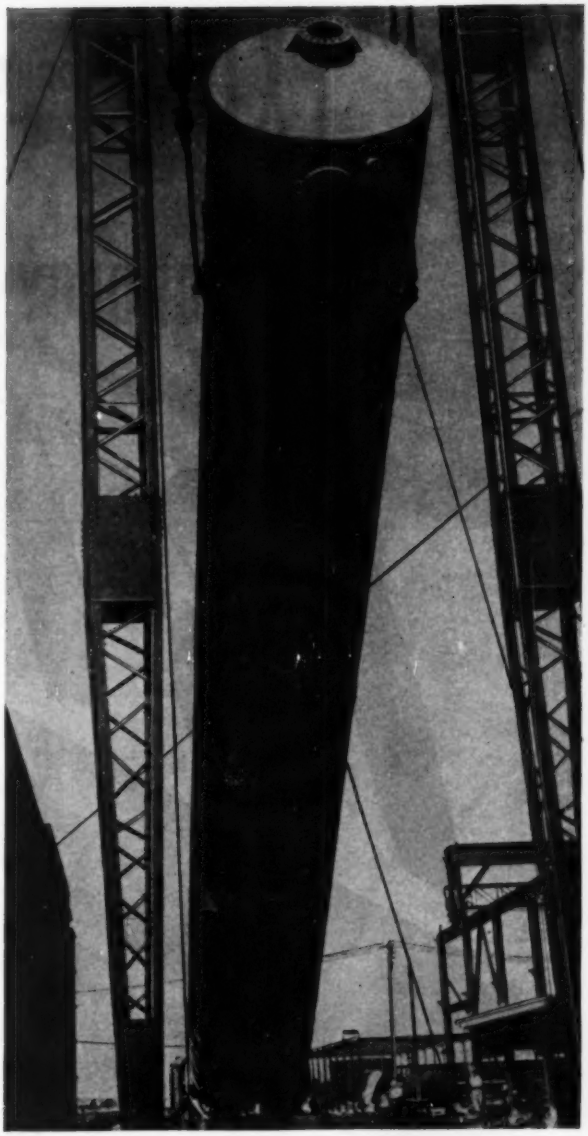
MADE-TO-ORDER UNITS

for Petroleum and Chemical Processes

If you are a prospective purchaser of any such units, you will profit by consulting with Sun Ship. Here you have the benefit of long experience, exceptional skills and unlimited facilities. These facilities include our favorable location, because of which we can ship by water all units too large to be transported by rail... Also, the Sun reputation for building, reconditioning or repairing tankers and cargo vessels warrants your consideration when planning the overhauling or expansion of seagoing transport equipment.



Sun

SHIPBUILDING & DRY DOCK COMPANY

SINCE 1916

ON THE DELAWARE • CHESTER, PA.

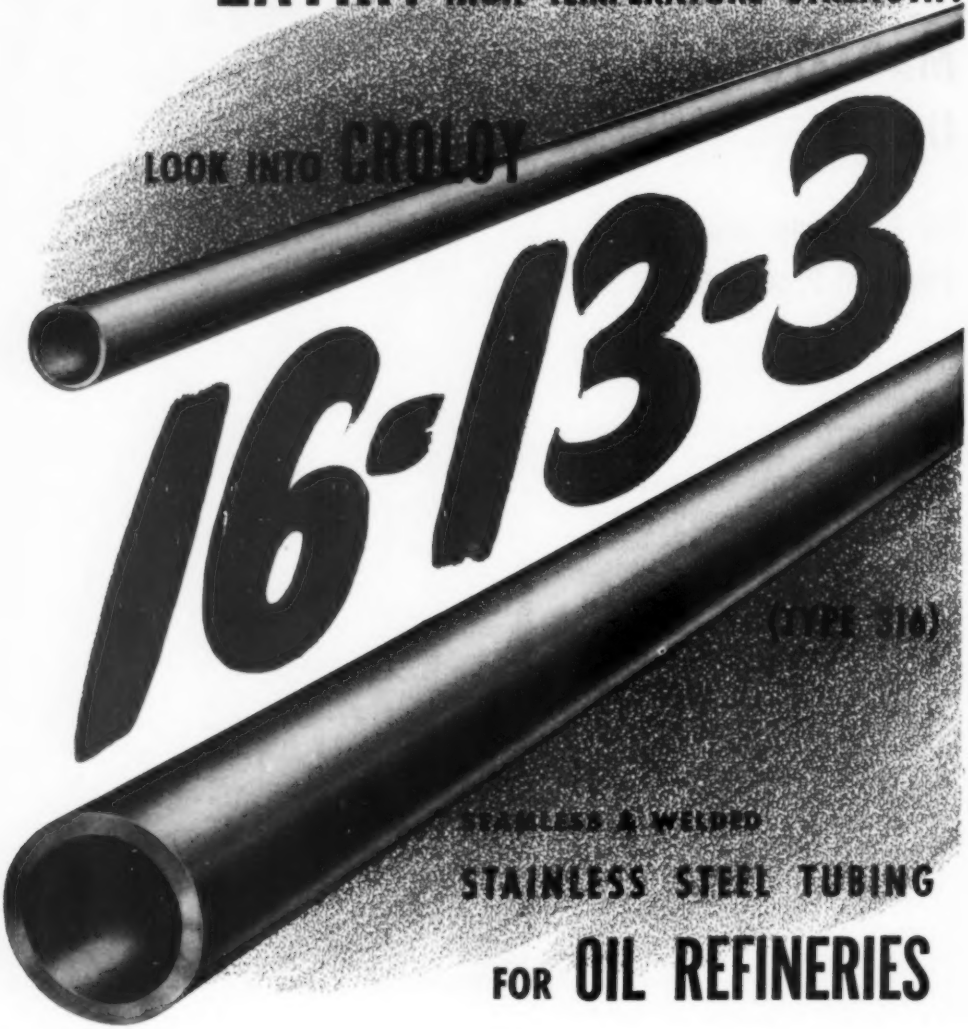
25 BROADWAY • NEW YORK CITY

LOOKING FOR EXTRA CORROSION RESISTANCE?
HIGH TEMPERATURE STRENGTH?

LOOK INTO CROLOX

16-13-3

(TYPE 316)



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STAINLESS STEEL TUBING
FOR OIL REFINERIES

Available also in modified analyses 18–13–3 (Type 317) for extreme corrosion conditions, and 16–13–3cb (Type 316cb) for applications where heat-treatment after welding is impractical. Ask for Bulletin TDC-133 describing physical, mechanical and fabricating properties of these analyses.

TA-1467-S

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A full range of Stainless, Alloy and Carbon Steel Tubing for all Pressure and Mechanical Applications

* *"Boiler Water Treatment? What's That?"*

THIS EGYPTIAN FERRYMAN doesn't need boiler water treatment. There's no boiler scale on his biceps . . . no equipment to corrode . . . and as for carryover, he gets paid for that. • But these problems can be serious in plants powered by steam instead of sinews, or where water is used for process or cooling. That's why so many engineers depend on Bird-Archer's 8-Point Water Treatment Service. Backed by a half-century of experience, Bird-Archer has developed methods that effectively combat scale, corrosion and carryover . . . methods that keep operating costs DOWN and equipment efficiency UP. • For a profitable discussion of your water treatment problems, ask to have a Bird-Archer Field Engineer pay you a visit. There's no obligation.

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NEW BULLETIN

CORROSION PROTECTION OF STEAM CONDENSATE RETURN SYSTEMS

Just off the press, this informative bulletin outlines the Bird-Archer method of amine treatment. Write for your free copy today.

• Perhaps you don't today. But what will you do when you need help in evaluating crude stocks, in boosting product quality, in cutting processing costs . . . in meeting the complex problems you may face tomorrow? Can you count on the kind of help you need . . . when you need it?

UOP

Catalytic Polymerization Unit Added by McMurrey

By O. C. DeLoach
Secretary & Plant Superintendent
McMurrey Refining Company

A catalytic polymerization unit, recently placed on stream at the Tyler, Tex., plant of McMurrey Refining Co., marks the latest step to be completed in a program of expansion and improvement begun soon after our refinery was built in 1931.

O. C. DeLoach

The poly unit, which is of the chamber type, with a single tower and multiple catalyst beds, was designed by Universal Oil Products Co. and built by our own construction department.

Charge stock to the poly unit is the net stabilizer gas from our thermal cracking unit, also designed by UOP. Its composition and that of the polymer product leaving the poly plant are shown in the following table.

	Fresh Feed Gas Mol. %	Polymer Gasoline Liquid Vol. %
Hydrogen		
Methane	1.8	
Ethylene	1.8	
Ethane	7.6	
Propylene	14.1	
Propane	24.5	
Isobutane	3.5	0.4
Isobutylene	7.2	0.1
n-butylene	15.2	2.5
Normal butane	22.4	13.9
Pentanes	1.9	9.2
Hexanes plus		73.9
	100.0	100.0
Specific gravity of hexanes plus		0.7316
Properties of Polymer Gasoline		
End point °F		396
RVP, pounds		12.3
Specific gravity		.7082

The poly unit has been producing approximately 150 b/d of polymer, which represents about 4 per cent on the topped crude charged to the cracking unit and an 8 per cent increase in gasoline yield.

Save on Lead Requirements

Not only is the overall production of gasoline thus increased, but the addition of high octane polymer to the motor fuel considerably reduces the amount of tetraethyl lead required to maintain our octane standard at 80ASTM and 88 Research for premium gasoline. The polymer has an 82.5 ASTM octane rating and 100 ASTM blending value. Catalyst life during the first run, which ended Sept. 13, 1948, was 77.8 gallons of 2 lb. RVP polymer per pound of catalyst. Olefin conversion rate is about 90 per cent.

A number of catalytic polymerization

(Advertisement)

units have been installed since the war to process gases from catalytic cracking units. Many of these have been built by the adaptation of existing equipment. By contrast, this unit, designed to polymerize thermally cracked gases, has been built with all new material from the ground up in accordance with our policy.

In operation, the gas from the cracking plant stabilizer is caustic washed and water washed. It is then picked up by a compressor and passed through the catalyst tower, and after exchanging heat with the catalyst tower effluent, is further heated to reaction temperature by means of a hot oil exchanger. Liquid butane is employed as a quench for catalyst temperature control. The catalyst tower effluent is fractionated to produce a stabilized polymer and a butane fraction used in the gasoline blends for vapor pressure control.

Average Operating Conditions

Average operating conditions for the unit are shown below:

Catalyst Temperatures	
No. 1 bed – Avg. °F	400
No. 2 bed – Avg. °F	405
No. 3 bed – Avg. °F	410
Catalyst tower pressure	450 lbs. per square inch
Polymer production	150 B/D Average
Yield of Polymer	
Volume percent on topped crude	4.0
Olefin Contents – Mol. %	
Fresh feed	34
Combined feed	22
Butane and lighter effluent	5
Polymer Inspection	
RVP, pounds	12.0
API gravity, degrees	68.0
ASTM distillation	
IBP	95
10%	160
50%	230
70%	260
90%	360
E.P.	400
ASTM gum mgs/100 ml	1.2
ASTM octane number	82.5

Many of the advances in refinery design made since 1931 are exemplified in the McMurrey refinery of today. Originally it was a skimming and vis-breaking operation only, with a charge capacity of 12,000 barrels per day of East Texas crude. Products were straight-run gasoline, kerosene and fuel oil.

Two years later, a thermal cracking unit with a design capacity of 1,500 barrels per day of gas oil was built.

Rebuilt in 1937

In 1937 the refinery was completely rebuilt and modernized under UOP's supervision. The existing cracking plant was converted to a UOP two-coil selective cracking unit to crack 3,750 b/d of a wide variety of charging stocks.

The refinery still operates on East Texas crude, gathered and delivered to the plant by our own pipeline system. In addition to gasoline, we are now producing naphtha, kerosene, Diesel fuel and No. 6 fuel oil. These are marketed chiefly by tank car and truck.

(Advertisement)

• A hand is always available to the refiner who uses Universal service. This service is his assurance of technical and operating assistance when unusual difficulties arise or when a series of normal problems makes time important. Universal service means help . . . when you need it.

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UOP

General Offices: 310 S. MICHIGAN AVE., CHICAGO 4, ILLINOIS, U.S.A.
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Master Speedrangers provide this infinitely variable speed in compact, all-metal, mechanical variable speed units in a wide range of types and in sizes up to 5 horsepower.

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For example, see how the Speedranger on this Rockwell packaging machine incorporates an electric motor, a variable speed unit and a gear reduction unit . . . all standard Master units that easily combine into a compact, integral power package. This provides exactly the RIGHT horsepower, the RIGHT range of speed, the RIGHT features, in a unit that you can use RIGHT where you want it.

Write for Data 7525, a new 24-page book on Speedrangers, and see what a real job they can do for you.

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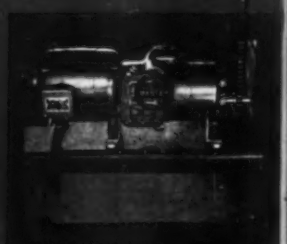

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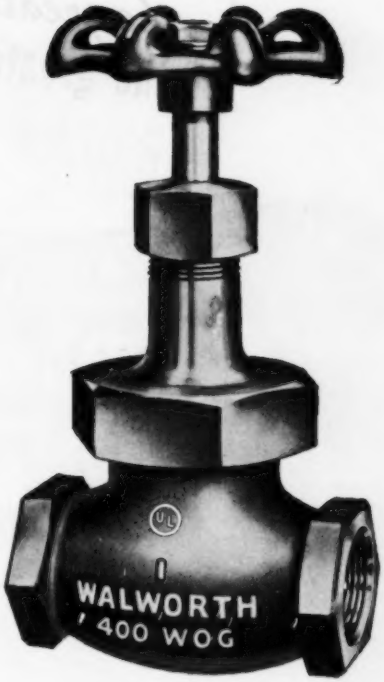
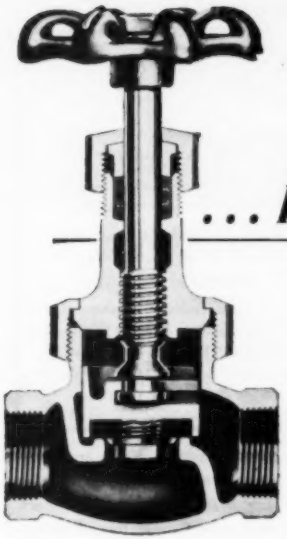
Built for LP-Gas Service

Approved by Underwriter's Laboratories





... inside and out!

Walworth's No. 91 Bronze Globe and No. 92 Bronze Angle Valves are designed especially for liquefied petroleum gas service.

These valves have rising stems and union bonnets. The stuffing box has a gland and is packed with a special material suitable for LP-Gas service, which gives a free-turning valve stem without leakage. The valve can be repacked under pressure when fully opened.

The discs are made of a synthetic rubber-like material unaffected by liquefied petroleum. These discs are cemented to the holders and further secured by the usual disc nut. Disc holders can be removed and new ones inserted easily and quickly. If the valve is fully opened before the bonnet is removed, the disc holder cannot fall from the stem. The disc holder's special construction keeps the disc accurately guided under all installation positions.

These quality valves are rated and marked 400 pounds WOG. *They are approved by the Underwriter's Laboratories for Liquefied Petroleum Gas Systems*, and meet all safety regulations now prevailing in the industry, such as those published in pamphlet No. 58 of the National Board of Fire Underwriters.

For further information on these long-life, economical Walworth Bronze Valves see your nearby Walworth distributor, or write for Circular No. 100.

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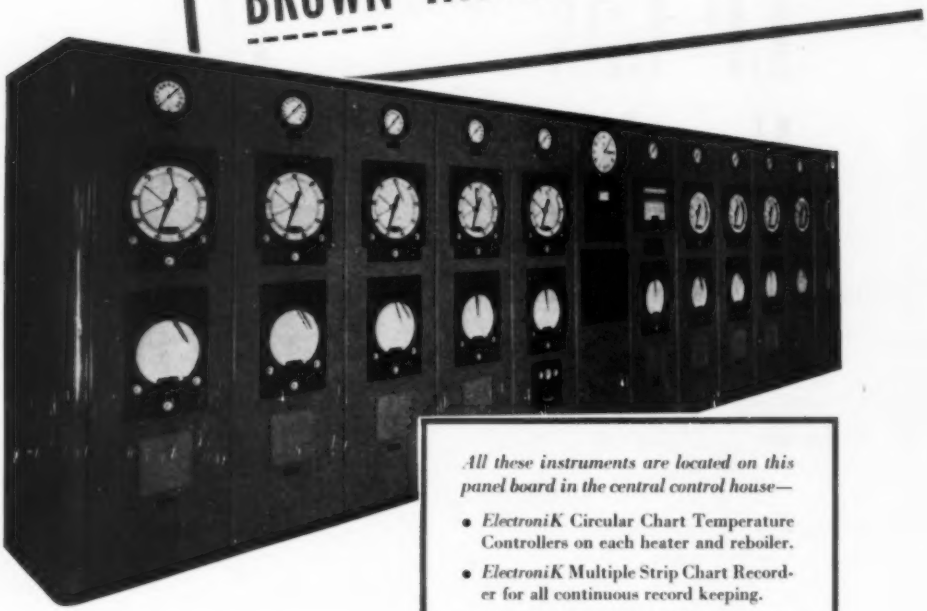
the greater the Precision
the greater the need for
BROWN INSTRUMENTATION!



All these instruments are located on this panel board in the central control house—

- *ElectroniK* Circular Chart Temperature Controllers on each heater and reboiler.
- *ElectroniK* Multiple Strip Chart Recorder for all continuous record keeping.
- *ElectroniK* Precision Indicator to give process conditions at locations selected by the push of a button.
- Brown Flow Controllers (with Pneumatic Transmission) on Main Lean Oil, Rich Oil to Reabsorber, Lean Oil to Reabsorber, Stabilizer Reflux, and L.P.G. Reflux.

Skelly uses Brown Instruments for control of processing operations at new Velma Plant . . .

THE unusual operational features which distinguish Skelly Oil Company's new natural-gasoline plant at Velma, Oklahoma, serve to simplify processes and reduce operating costs. Designed and constructed by Born Engineering Company of Tulsa, this plant heralds a new approach which means *even greater reliance* upon automatic control . . . and that's where Brown fits into the picture.

Brown Advanced Instrumentation fits into this picture because it keeps pace with every new demand for increased sensitivity, greater accuracy and faster response . . . with the flexibility required by modern processing techniques.

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BROWN INSTRUMENTS DIVISION
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Offices in principal cities of the United States, Canada and throughout the world

MINNEAPOLIS Honeywell — *Advanced Instrumentation* FOR THE PETROLEUM INDUSTRY — BROWN INSTRUMENTS

N.B. While it is axiomatic that return on investment—the *ultimate earning power* of a refinery unit when actually on stream—is the only true evaluation of competitive engineering recommendations, initial plant costs remain a major factor in refiners' decisions on plant installations. M. W. Kellogg takes specific steps to *minimize initial plant costs* consistent with the achievement of *highest ultimate earning power.*

CUTTING FIELD WELDING TIME BY 15%!

Preheating piping and shapes to be welded in the field is an essential step in the construction of any refinery unit. For many years it was the accepted custom to use gas heating devices for this purpose. These heaters accomplished the preheating satisfactorily, but they had many disadvantages which slowed down the job.

The gas heating equipment—rings and straight lines of gas burners—was cumbersome to handle, difficult to position in close spaces, required wind screens to keep flames concentrated on even slightly windy days, and presented a constant hazard of open flame to welders who of necessity had to operate close by.

In the constant search for better methods of construction that would either improve the quality of construction or lower its cost—or do both simultaneously—Kellogg's metallurgical technicians, welding practice laboratory and construction groups combined in pioneering a new method of preheating.

Known as *strip-heating,* this new method utilized low voltage electrical resistance heating. It eliminated all disadvantages of gas heating plus adding measurable improvement to *control* of the operation itself.

This improvement, in working conditions and in quality of work, would have been sufficient reason to adopt the new method. However, actual experience in the field proves that this new method of preheating produces a 10 to 15% saving in welding time . . . this on top of all its other advantages. When it is realized that the average cat-cracker embraces tens of thousands of welding hours, at an average hourly cost in excess of $2.50, the saving is seen as an appreciable one.

M. W. Kellogg believes that a *complete,* integrated organization, having within itself all types of specialists required to solve just such problems as this one of field preheating, is the only true approach to LOW INITIAL PLANT COSTS.

THE M. W. KELLOGG COMPANY
A SUBSIDIARY OF PULLMAN, INC.
ENGINEERS TO THE PETROLEUM INDUSTRY
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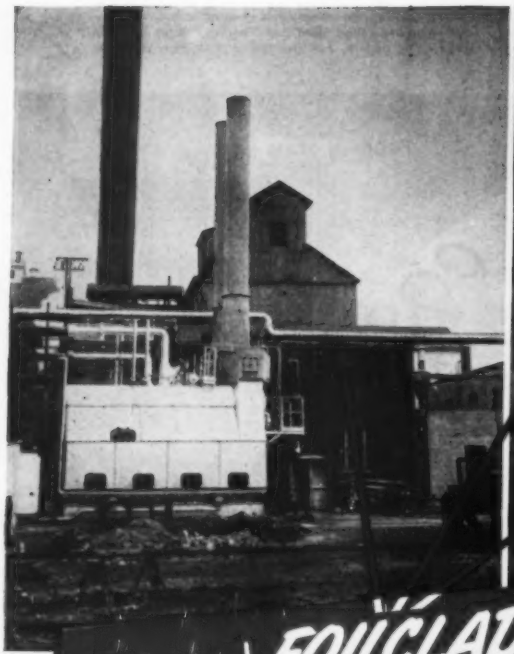

3-Level FOILCLAD Steam Line Helps Commercial Solvents Do a 4-Way Job

Steam for These Important Uses at CSC's Research Center is Distributed at 125 psi in 8 inch SBS Pipe in Ric-wiL Prefabricated, Pre-insulated, Aluminum Foilclad Pipe Units:

1. General Purpose Building Heating
2. Autoclaves and Sterilizers
3. Sterilization of Process Equipment in Microbiological Pilot Plant
4. Operation of Steam Ejectors

For complete information on the construction and the many advantages of Ric-wiL Foilclad Insulated Piping, write: The Ric-wiL Company, Dept. 14K.

● Chemicals of vital importance to American farming, industry, transportation and medical science are produced in wide variety at the nine great plants of Commercial Solvents Corporation. Key operation in these enterprises is CSC's Research Department in Terre Haute, Indiana, for the development of new products and new manufacturing processes, and the improvement of existing processes.

A large scale operation of utmost importance, the very nature of these activities requires the widespread use of large quantities of insulated piping of high thermal efficiency and proved dependability.

A recent installation of Ric-wiL Aluminum Foilclad Piping at this research center is a typical demonstration of the ability of Ric-wiL factory-prefabricated insulated pipe units to meet the special requirements of chemical plants, petroleum refineries, railroads and similar industrial operations. To meet specific project conditions this Unibestos-insulated, asphalt-coated and aluminum-protected 8" steam line in standard 21 foot units was installed on three levels —in a tunnel under a roadway, on concrete piers at surface level, and suspended overhead.

"When you want this valve to work . . . it works"

it's

Stick-Proof

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LEVER-SEALD

HOMESTEAD LEVER-SEALD VALVES operate *instantly* with only a *Quarter-Turn* . . . at all times and under all conditions . . . in services where extremes of temperature, pressure, or the corrosive action of line fluids would cause ordinary valves to stick or "seize."

That's why they have been favorites with industry for more than 15 years in all sorts of difficult applications.

They're *stick-proof*, because built right into each valve is a powerful lever and screw device that *relieves seating pressure* between plug and body just enough to overcome friction and permit *easy turning*.

This *stick-proof* construction is only one of many HOMESTEAD LEVER-SEALD VALVE features assuring long, economical, trouble-free service.

You may order HOMESTEAD LEVER-SEALD VALVES in metals and alloys to meet service requirements, in sizes from 1½" to 12" with regular or wedge gate valve face to face dimensions, for pressures from vacuum to 1500 pounds. Complete technical details and Valve Reference Book No. 38 are yours for the asking.

CHECK THESE OUTSTANDING LEVER-SEALD VALVE FEATURES

1. Instant stick-proof operation.
2. Quarter-turn fully opens or closes.
3. Positive mechanical seal.
4. Seating surfaces always protected in both open and closed positions. Corrosion practically eliminated.
5. Unobstructed straight-line fluid flow.
6. All operating parts protected from damaging effects of service conditions and weather.

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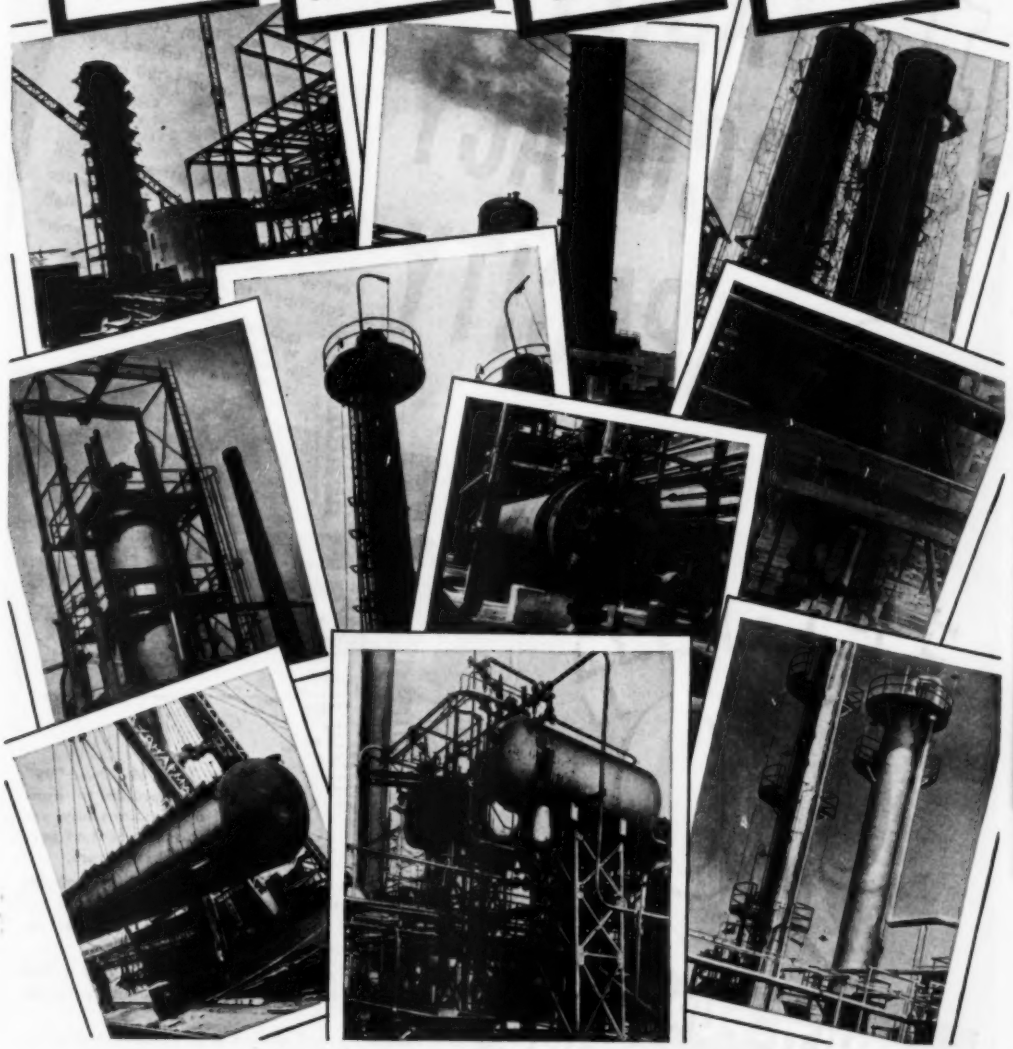

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2 ACCURACY
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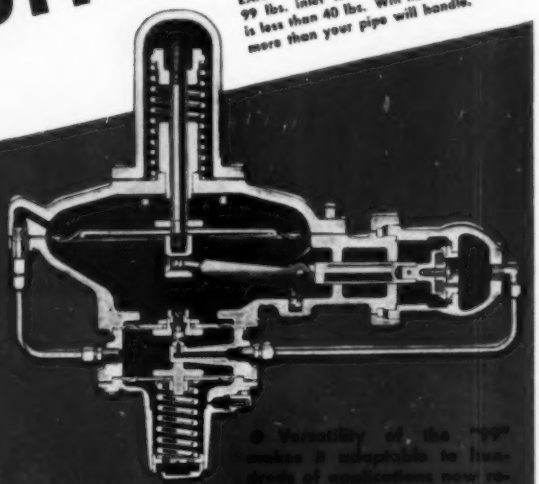

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Overload trip features shut-off in event reduced pressure tends to rise too high.

One body size (2" screwed) and one orifice size handle full range of capacity and pressure conditions.

Single seated orifice with composition valve disc gives tight closure when needed.

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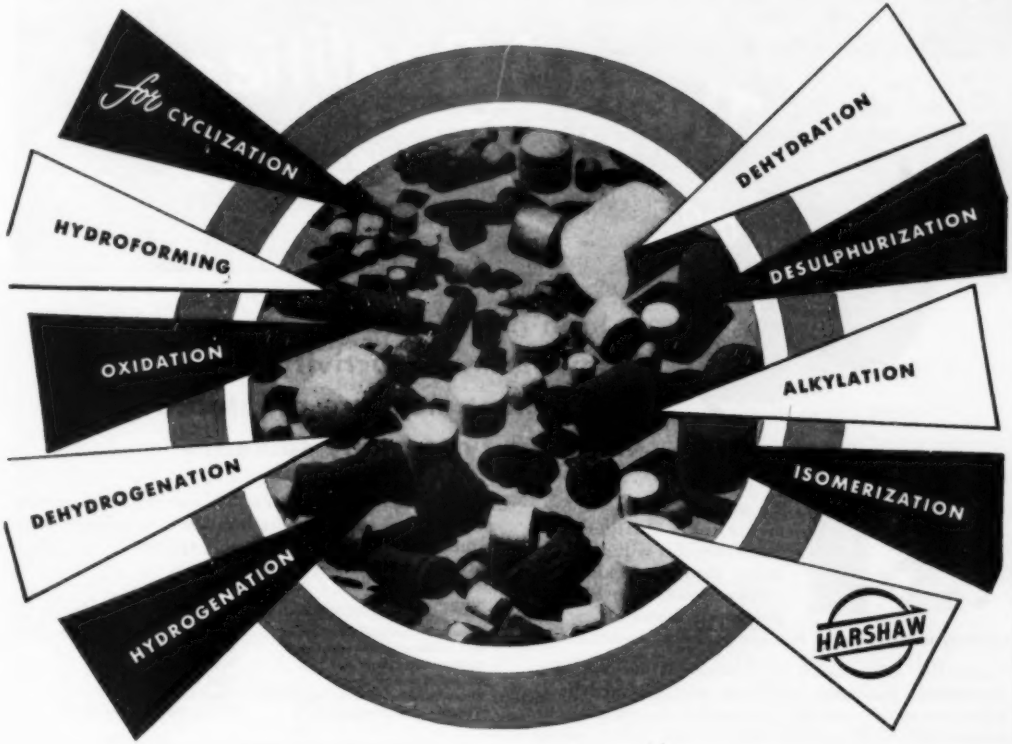

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1. high fire resistance
2. low heat conductivity
3. excellent moisture resistance
4. immunity to many solvents

To meet industry's requirements for a refrigeration insulation that will stand up under many new kinds of service, Johns-Manville has developed Zerolite* . . . an entirely new *inorganic* low temperature insulation.

Zerolite is intended for industrial use where a dependable insulation with low heat conductivity is important to the economical operation of a system. The temperature range of Zerolite is from 400 F below to 170 F above.

Zerolite sheets, lagging, and pipe insulations are made from mineral wool, processed with a special resin binder that provides exceptional moisture resistance. Available in wide variety of sizes and thicknesses. The pipe insulation is further provided with an asphalt jacket that protects both longitudinal joints.

*Reg. U. S. Pat. Off.

Skilled application service. To assure the maximum return from your Zerolite insulation investment, have your next job engineered and applied by a Johns-Manville insulation contract firm.

ZEROLITE is recommended for insulating:

Petroleum dewaxing equipment	Solvent storage and piping
Gas purifiers and condensers	Ammonia lines
Chillers and exchangers	Cold tanks and vessels
Chemical process lines	Cold water lines
Pharmaceutical process equipment	Freon lines
Reactors and economizers	Air conditioning equipment

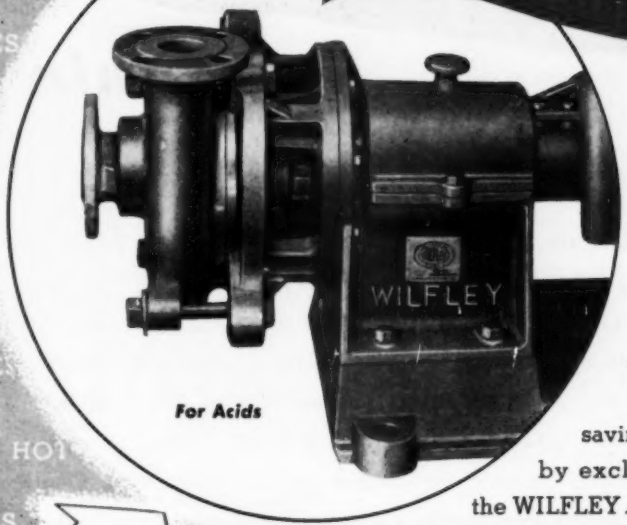
Send for this Folder

This new folder contains descriptions, property tables and other data on Zerolite's advantages. Write Johns-Manville, Box 290, New York 16, N. Y.

Johns-Manville ZEROLITE

REFRIGERATION INSULATION

A BIG FACTOR IN Reduced OPERATING COSTS



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American engineering practice

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HEAD WRIGHTSON PROCESSES LIMITED are Accredited Engineers for Leading American Refinery Processes including Thermal and Catalytic Cracking and Reforming, Solvent Extraction and Dewaxing, Desulphurisation, Chemical Treating, Continuous Charcoal Adsorption, etc. . . . All Plants engineered in strict accordance with American practice, and to American Codes. . . . Ten plants, including some of the largest Solvent Extraction Plants in the World, engineered by Head Wrightson Processes Ltd., are now in course of construction. Our services comprise engineering, purchasing, progressing, inspection, shipping, and supervision of erection.

•

Head Wrightson Processes Ltd.

AMERICAN TECHNOLOGY BRITISH ENGINEERING

TEESDALE HOUSE 24-26 BALTIC STREET LONDON E.C.1

146—1.

MASONEILAN

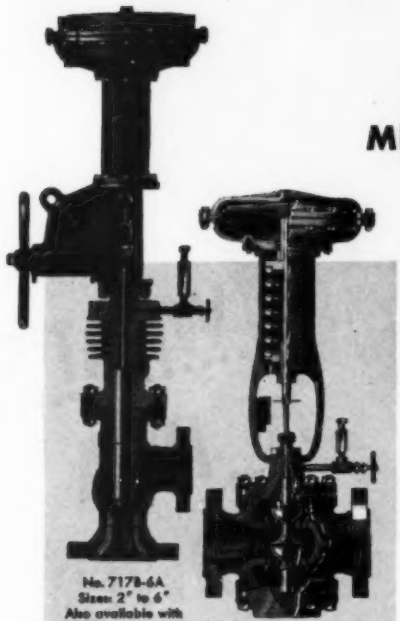
Control Valves

MEET THE EXACTING REQUIREMENTS

OF THE PROCESS INDUSTRIES

Masoneilan Control Valves are available for every usual application . . . steam, water, oil, gas or chemicals. These outstanding valves are built to exacting Masoneilan standards to assure dependable performance under all operating conditions. Field-tested, job-proved, these control valves are demonstrating their ability to perform in hundreds of installations throughout the world. Almost daily, users report that Masoneilan Control Valves give years of continuous service with minimum maintenance.

Masoneilan Control Valves are available in a wide range of types and sizes from ⅛" orifice and up. Call our nearest office for complete details.



No. 7178-6A
Sizes: 2" to 6"
Also available with expanded outlet

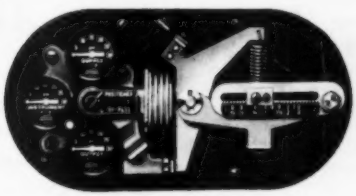
No. 37
Percentage
Parabolic
Sizes: 1" to 6"

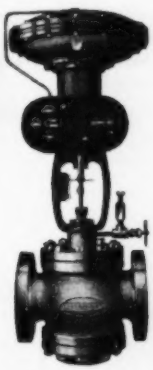
No. 38
Percentage
V-Port
Sizes: 1" to 14"

No. 37
Percentage
Piston
Orifice sizes:
⅜" to ⅝"
Body sizes: ¾", 1"

No. 107
Orifice sizes:
⅛", ¼"
Body size: ½"

MASONEILAN





7400 Control Valve Positioner
Accurately Positions Valve Plug

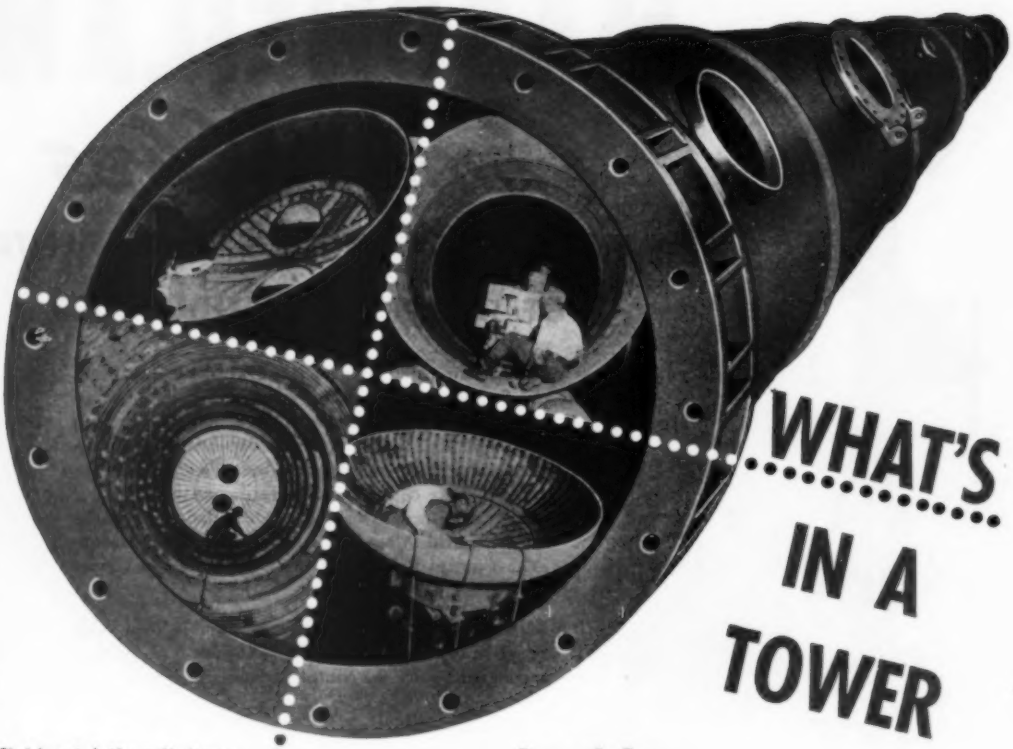
For use with diaphragm control valves or diaphragm motors — direct or reverse super-structure. For split range operation and motion transmission. Positions the valve plug in exact proportion to changes in controller output pressure. Simple and easy to install. Rugged, weatherproof case.

MASON-NEILAN REGULATOR CO.

1203 ADAMS STREET, BOSTON 24, MASSACHUSETTS

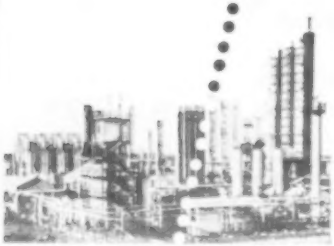
Sales Offices or Distributors in the Following Cities — New York • Buffalo • Chicago St. Louis • Philadelphia • Houston • Pittsburgh • Cleveland • Tulsa • Atlanta Denver • Cincinnati • Los Angeles • San Francisco

Mason Regulator Co. of Canada, Ltd., Montreal and Toronto



WHAT'S IN A TOWER

Fluid catalytic unit tower 8'0" ID x 50'0" 5/8" steel shell, clad with 12 gauge stainless steel strips, complete with tray supports...Nooter fabricated to Universal Oil Products Co. design.



besides design and metal?

Well, for one thing: Over one mile of Nooter *DuraPure* Welding. The continuous automatic and manual arc-welded construction surpasses API-ASME Code specifications. . . Uniform bond achieves high strength, and surface purity of welds maintains corrosion-resistance. Stress-relieving insures safety and precise, undistorted alignment.

After being cross-checked for precision fit-up the vessel was shipped on schedule — ready for erection.

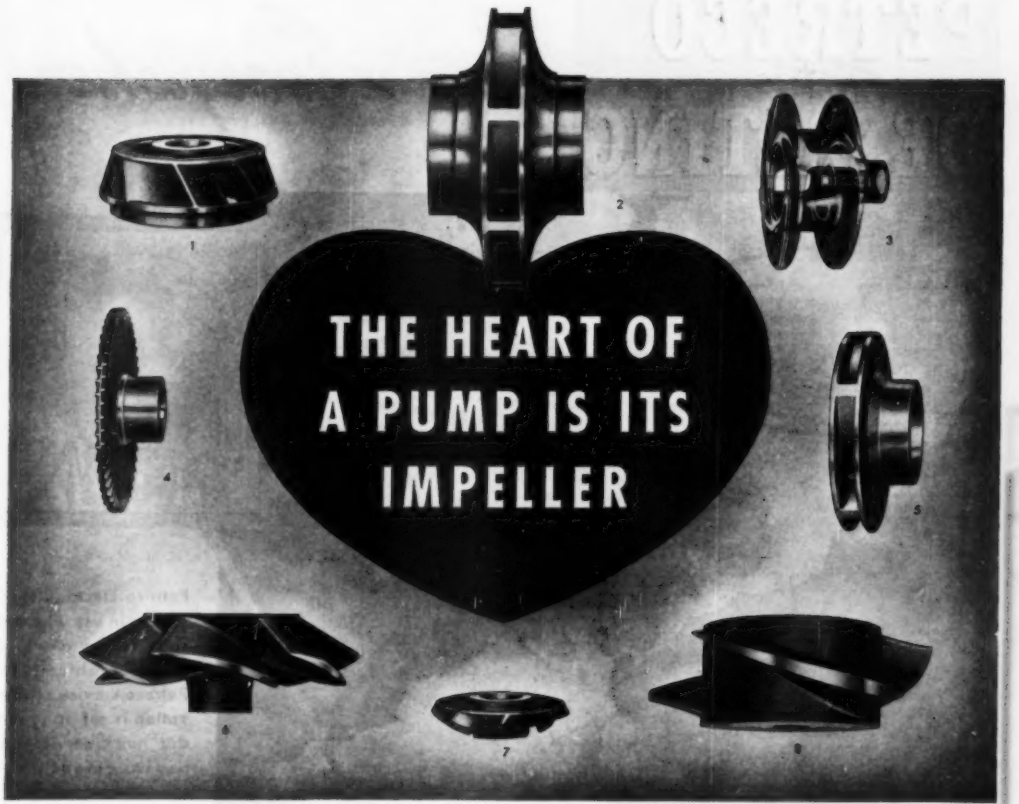
This is why Nooter-fabricated equipment is competently serving the petroleum industry throughout the world.

When your blue prints are ready — call in Nooter!

NOOTER

Nooter Catalog, complete with corrosion data charts is sent at your request.

JOHN NOOTER BOILER WORKS CO. • 1404 South Second St. • St. Louis 4, Mo.



Peerless Pumps utilize many different impeller designs to meet various fluid conditions

What makes a pump "tick?" Its heart is an impeller!

Pictured above are eight Peerless impeller designs for varying fluid conditions. No. 1 forces water upward from deep wells. No. 2 is a double suction design for high capacity horizontal pumps. No. 3 pumps solids in suspension. No. 4 handles all liquids in small capacities, at high heads. No. 5 is of single suction design for process services. No. 6 combines both radial and axial flow. No. 7 is a semi-open impeller for small diameter deep wells. No. 8 is an impeller that "propels" large liquid volumes.

The point is—capacities, lifts, heads, temperatures, chemical analysis, clarity, shaft speeds are seldom common to different pump services and installations. Because fluid conditions vary, Peerless pump designers are versatile and Peerless pumps utilize this versatility in different impellers for varying fluid conditions, successfully pumping most liquids in all industries.

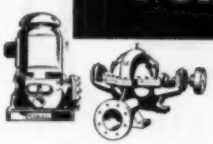
Peerless horizontal pumps are available for general purpose pumping, for handling sewage and other materials in suspension, for most all process services, for moving chemicals and oils, for acids and caustics and for such specialized applications as l-p gases.

Peerless vertical turbine pumps are available for lifting water from deep wells or close-coupled for wet or dry pit installation and for drainage, drydock, canal diversion and flood control services.

Plan with Peerless for all your needs for pumps. Individual descriptive Bulletins on each of the types of Peerless Pumps described above are available upon request.

Peerless
VERTICAL AND HORIZONTAL
Pumps

PEERLESS PUMP DIVISION
FOOD MACHINERY AND CHEMICAL CORPORATION
Los Angeles 31, California — Indianapolis, Indiana
District Offices: New York 5, 37 Wall Street; Chicago 40, 4554 N. Broadway; *Atlanta Office:* Rutland Building, Decatur, Georgia; Omaha, Nebraska, 4330 Leavenworth Street; Dallas 1, Texas; Fresno, California; Los Angeles 31, California



PETRECO Electric DESALTING

Service Everywhere

Petreco Electric Desalters are in use wherever salty crudes are a refining problem. The Petreco service organization is set up to render quick service and replacement parts whenever needed.

PETROLEUM RECTIFYING COMPANY

5121 South Wayside Drive
Houston 1, Texas

•

648 Edison Building
Toledo 4, Ohio

•

530 West Sixth Street
Los Angeles 14, California

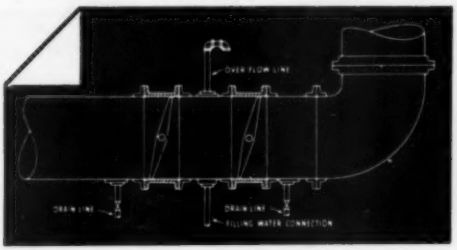
PETRECO

SPECIALIZED *Electric* PETROLEUM PROCESSES { DESALTING / DEHYDRATING

R-S valvEvents

• EXCERPTS FROM THE R-S BOOK OF EXPERIENCE •

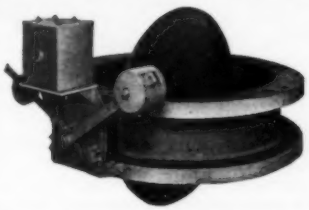
How to Seal a Gas Line



The sealing of gas lines is required in many plants as a protective measure. It is advantageous to adapt the method sketched above because of its low cost, positive seal and the fact that it requires minimum space in the line.

When the gas is to be shut off, the two R-S Valves are closed and the space between filled with water or other material, thus forming a tight seal.

Immediate Shut-Off or Vent



No. 628. Should solenoid operator function, the R-S Valve installed in a line either closes or opens immediately.

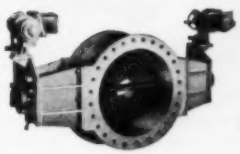
The R-S Solenoid Trip Valve is used for emergency service. The solenoid can be arranged with the counterweight mechanism to open or close the valve and hold it there in one position or the other. If for any reason the solenoid functions, the latch is tripped, which permits the counterweight to open or close the valve by gravity. The assembly is suited to shut off the flow or to open a vent and requires manual reset. Can be constructed of any metal or alloy and in various sizes for air, gases, steam, oil, water and other services. Types 649 and 696 are spring loaded (spring utilized instead of counterweight). Very popular for marine service.

Write for catalog No. 17 or consult with the R-S representative in your locality. You will find the address and phone number listed under "R-S Products Corporation, Valves."

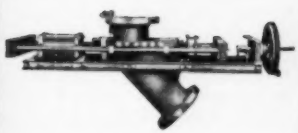
R-S Products Corporation, Wayne Junction, Philadelphia 44, Pa.

No. 728. 54-inch 50-pound Iron Valve for water service. Extremely rugged construction. Limitorque electric motor drive with threaded reach rod moves valve very slowly to prevent water hammer.

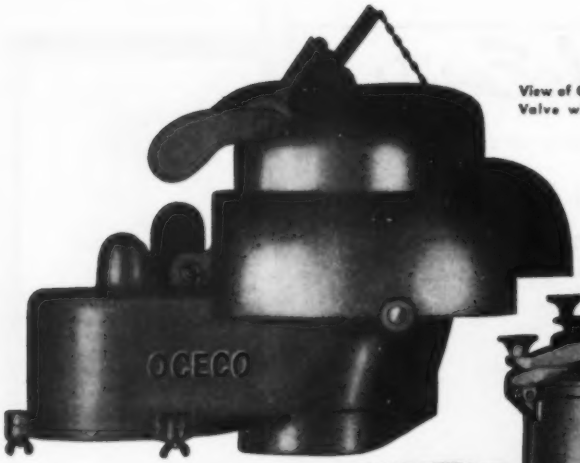
No. 722. 16-inch 125-pound Cast Iron Valve equipped with rubber spool for positive shut-off. Air Cylinder operated. Position of valve vane indicated by operating lights.



No. 725. 36-inch by 8-inch 150-pound Class B Alloy Steel Dual Valve. Controls high pressure drop and small volume or low pressure drop and large volume.



No. 719. 12-inch Steel Angle Slide Valve with 300-pound American Standard raised face flanges. Air cylinder and rising stem hand wheel operator with declutching unit. Controls liquids, gases and solids including catalysts.



View of Oceco 3" Screwed Connection Vent Valve with Flame Snuffer and Chain.

OCECO
V-113 VENT VALVES
for maximum efficiency, economy and dependability

View of Oceco 6" Flanged Connection Vent Valve showing mounting on Oceco Flame Arrestor.

● Oceco Vent Valves provide positive and dependable control of tank breathing. They prevent the free discharge of vaporized liquids resulting from fluctuations in temperature,—and restrict tank breathing, resulting from pumping into a tank. They avoid any serious lowering of gravity ratings;—retard the formation of gum;—and avoid "cave-ins" and "blow-outs" resulting from excessive vacuum and pressure.

These valves combine the advantage of our twenty five years of experience in meeting the industry's most exacting requirements;—and the results of exhaustive tests conducted in our laboratories. The Venturi effect of the body gives the valves even greater pressure capacity than an open nipple, while the spacing and design of the openings provides large vacuum relief. The drip edges on the valves carry away any condensate, thus protecting the valves against corrosion and freezing, and the stem guided construction prevents sticking and "cocking."

The housings are semi-steel castings that can withstand direct exposure to flames for long periods of time, and consequently provide a solid support for the valves, valve guides and seats, keeping them in proper alignment and assuring tight closure at all times.

Furnished in 2" and 3" sizes for screw mounting, and 4", 6", 8", 10" and 12" sizes for flange mounting, either as individual units or complete with an Oceco Flame Arrestor. Prices and a fully descriptive bulletin sent promptly on request.

OCECO

***Division of* THE JOHNSTON & JENNINGS CO.**

CLEVELAND 14, OHIO

NEW YORK • PITTSBURGH • DETROIT • CHICAGO • ST. LOUIS • TULSA • BEAUMONT
MOBILE • CASPER • SAN FRANCISCO • LOS ANGELES • TORONTO AND MONTREAL

ALOYCO STAINLESS STEEL VALVES

(quote) *maintenance is nil* (unquote)

Aloyco Stainless Steel Valves in the Acid Plant of the Daugherty Refinery division of L. Sonneborn Sons, Inc. at Petrolia, Pennsylvania.

Aloyco Flanged Gate Valve, No. 111, 150 lb., ½" to 12" inclusive. Available in 18-8S, 18-8SMo, Aloyco 20 and other corrision-resistant alloys.

"ONE of the most interesting observations we have made insofar as Aloyco Valves are concerned is that the maintenance to this date has been nil. In two years of service we have never lost a minute of operating time with Aloyco Valves. I would heartily endorse Aloyco 20 Valves for similar services". The remarks are those of Mr. G. H. Miley, Acid Plant Superintendent of the Daugherty Refinery, Petrolia, Pennsylvania, a division of L. Sonneborn Sons, Inc.

The Aloyco Valves here are used in the acid control lines of their contact H_2SO_4 plant. They handle 93% and 98% H_2SO_4 and oleum in temperatures ranging from 115° to 150°F. This Company formerly used iron and steel valves with alloy trim for the same application. Aloyco Valves in this particular installation have been in service several times as long as any previous valves.

Let our sales engineers study your requirements.

ALOYCO

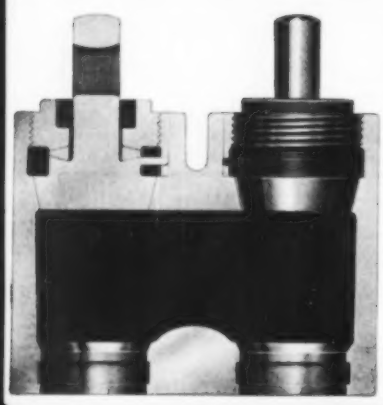
STAINLESS STEEL VALVES AND FITTINGS

ALLOY STEEL PRODUCTS COMPANY, INC.

OHIO Return Bends

extra **STRENGTH** *where needed*

Ohio Type 1640 is rated higher! It's built to take higher pressures and temperatures, built for greater strength at the top. The circular holding member distributes the pressure over the entire top, and the equalizer ring evenly applies the downward force from the holding member to the tapered seat. Force is applied nearer the outside diameter of the plug. Cut costs with tough Ohio Return Bends — "Extra Strength Where You Need It."



FAHRITE TUBE SUPPORTS

In the hottest spot in your refinery, FAHRITE tube supports stand up. They give longer, more economical service under extremely high temperatures. There's a grade of FAHRITE to suit your operating conditions. Write us today for more complete details.

THE OHIO STEEL FOUNDRY CO.

SPRINGFIELD, OHIO

Plants at Springfield and Lima, Ohio

DO YOU KNOW THESE

facts about treating?

FACT 1 Mercaptan *removal* is today's answer to deodorization problems.

FACT 2 Modernizing with the *Tannin Solutizer Process* for mercaptan removal yields "new refinery" economies in treating and blending your finished leaded gasoline.

FACT 3 *Conversion and operating costs* are extremely low.

FACT 4 The Tannin Solutizer Process is not *corrosive*.

FACT 5 The high efficiency of the Tannin Solutizer Process has been conclusively demonstrated during more than *five years* of commercial refinery operation.

FACT 6 The Tannin Solutizer Process does not affect the *stability* of the gasoline treated.

FACT 7 Complete Tannin Solutizer *process engineering* service is available—during the planning of your unit, at start-up, and thereafter if required.

We will welcome the opportunity to work with you on your specific problem. The Tannin Solutizer Process is licensed under the patent rights of Socony-Vacuum Oil Company and Shell Development Company.

SHELL DEVELOPMENT COMPANY, INCORPORATED

50 West 50th Street, New York 20, New York

SHELL

FIRE-PROOF

inside and out!

CMH REX-FLEX FIRE-PROOF FLEXIBLE METAL HOSE

FOR: Fuel and Process Lines and Fire Protection Systems

For services where the combustibility of materials handled demands that flexible connections be resistant to internal or external fire, CMH manufactures a truly *fireproof* flexible metal hose. Already widely used in critical applications, CMH REX-FLEX Fire-Proof Flexible Metal Hose has been subjected to the severest tests. Its use in processing plants and fire protection systems will provide new highs in safety not available in standard type hose assemblies.

CMH REX-FLEX Fire-Proof Flexible Metal Hose is available in sizes from 5/16" to 6" I.D. with a choice of standard fittings. Write for latest data and specifications for your requirements.

Undamaged after 10 hours of continuous internal fire . . .

In certified tests, CMH Fire-Proof Metal Hose was subjected to 10 hours continuous internal fire — without damage! It also withstood an external flame of over 2000°F. for over fifteen minutes—again without failure!

Here is a degree of safety that cannot be found in other types of hose construction!

CMH—ONE dependable source for every flexible metal hose requirement

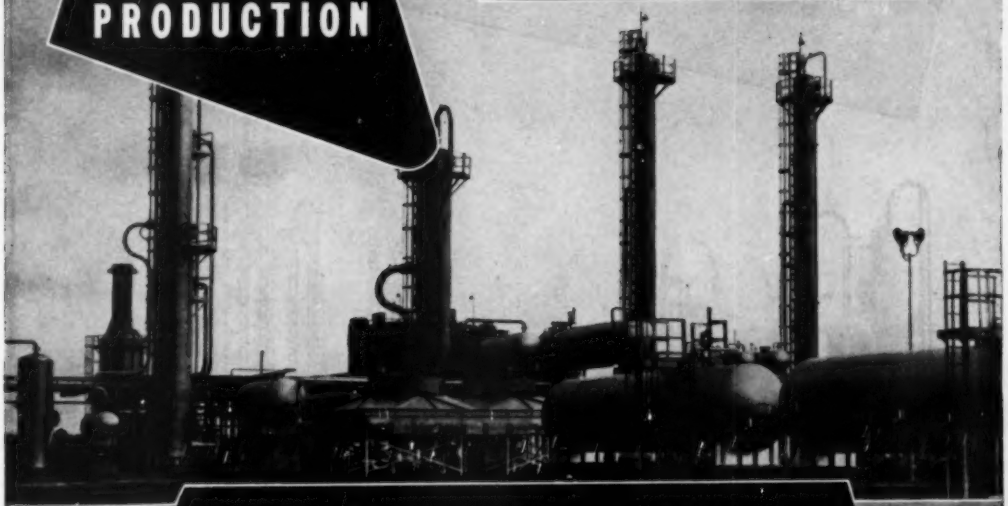
• CMH manufactures all standard types of flexible metal hose, both convoluted and corrugated, in a variety of metals; expansion joints for piping systems; stainless steel and brass bellows; various conduits and special assemblies of these components.

CHICAGO METAL HOSE CORPORATION

CMH

Leaders in the Science of Flexonics
MAYWOOD, ILLINOIS
Plants at Maywood, Elgin and Rock Falls, Illinois
In Canada: Canadian Metal Hose Co., Ltd., Brampton, Ontario
FLEXON . . . . . identifies CMH products which have served industry for more than 47 years.

FROM
PLANNING
TO
PRODUCTION



PRITCHARD Can Solve Your
Petroleum Processing Problems*

*You are invited to consult Pritchard on both phases of your next petroleum engineering project.

1. **OIL FIELD PROCESSES**—Cycling, Pressure Recovery Systems, Crude Stabilization, etc.
2. **REFINERY PROCESSES**—Distillation and Recovery Systems, Thermal Reforming, Cracking, Viscosity Breaking, Catalytic Reforming, Alkylation, Polymerization, Isomerization, Lube Processing, etc.

The Natural gasoline extraction plant, partially shown above, represents an installation designed, engineered and constructed from "scratch" to complete operation by J. F. Pritchard & Co., Petroleum Division. Thorough experience from many such jobs enables Pritchard engineers to develop your project in its entirety; in conjunction with others; or to work from plans furnished by you or your consultants. Any part of Pritchard's complete services is also available separately.

THREE FUNCTIONS— Engineering Construction, Manufacturing
IN FIVE FIELDS— Serving the CHEMICAL, POWER, PETROLEUM and GAS industries as well as providing specialized EQUIPMENT for all industries.

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908 GRAND AVE. • KANSAS CITY 6, MO.

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CHEMISTRY AT WORK
Fractionating Towers, fabricated by WYATT'S exacting workmanship, helping to produce organic chemicals from Propane and Butane gases.
Wyatt's
HOUSTON - DALLAS

Why Standard helps young scientists through school

The student's lamp that lights America's future never needed to burn more brightly than today.

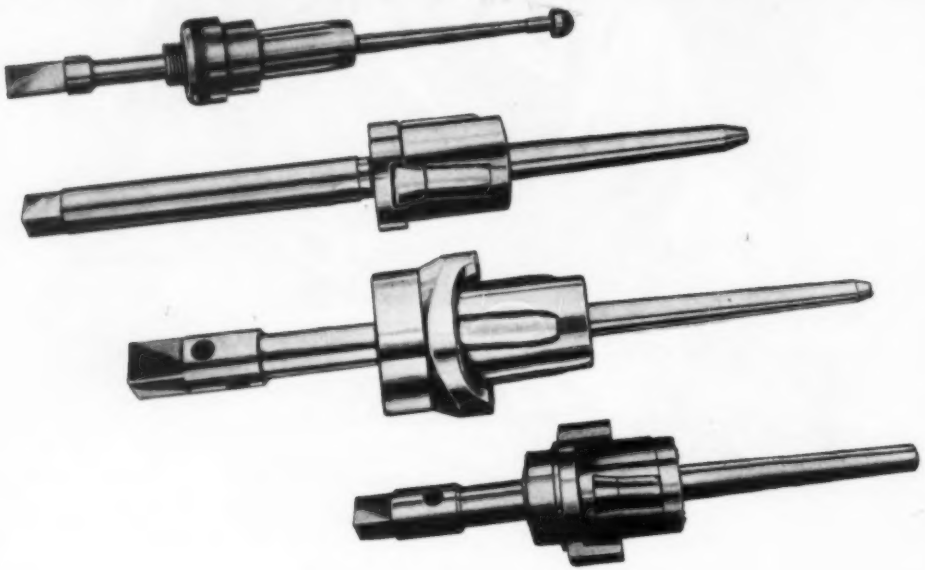
During this school year, we have extended our graduate fellowship program from 19 to 25 scholarships and have increased the grants from $1,000 to $1,250, plus tuition where it is needed. These scholarships are awarded by 14 universities to promising young scientists and engineers. We hope some of them may later work with Standard of California, but there is no obligation either in their choice of studies or career.

This is the eleventh year of these Scholarship Awards. It is our sincere hope they will help develop the well-trained men and women who can best insure continued progress for the West and the whole United States.

STANDARD OF CALIFORNIA
plans ahead to serve you better

Standard Oil Company of California

NOW...WILSON OFFERS A COMPLETE LINE OF WILSON-DUDGEON TUBE EXPANDERS



TUBE INSTALLATION AND MAINTENANCE go hand in hand on the new Wilson service team. For Wilson has supplemented their widely-used tube cleaners with a complete line of precision-made Wilson-Dudgeon tube expanders.

This double service to industry has been made possible by the purchase of the tube expander facilities of Richard Dudgeon, Inc., a firm with more than 75 years of experience in this field.

VITAL STATISTICS: Every Wilson-Dudgeon tube expander is made of the highest quality steel and is designed to give the smooth, efficient rolling action which insures firm seating for the tube. There is a Wilson-Dudgeon tube expander for every conceivable need, from $\frac{3}{16}$" I.D. to 24" I.D. in power plants, refineries, boilers, heat exchangers, condensers, evaporators, stills, etc.

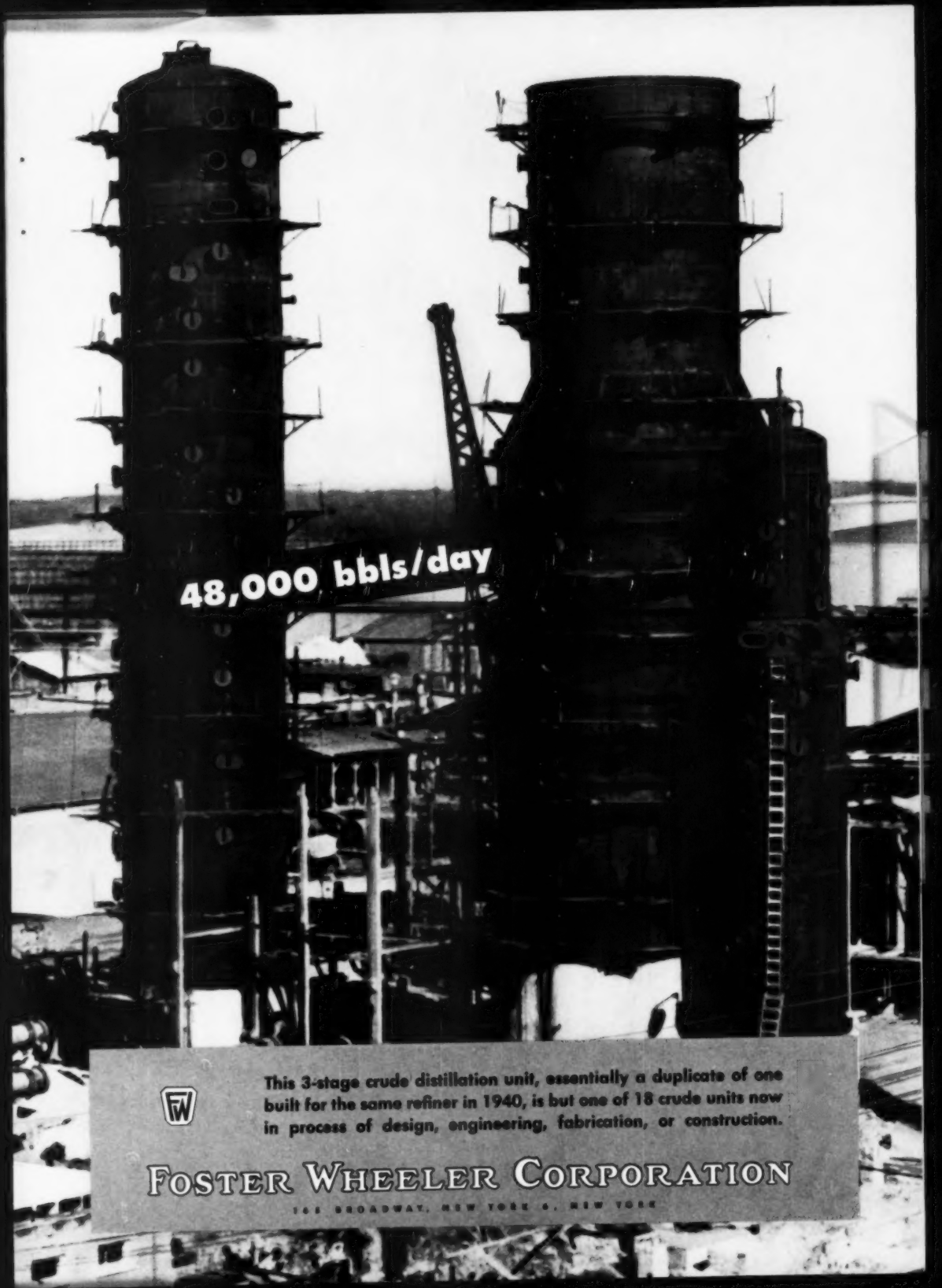
Investigate the Wilson-Dudgeon tube expander line. See how these skillfully made expanders seat tubes tightly . . . provide perfectly rolled joints . . . reduce time-wasting re-rolling and reinspection. Write today for full information.

THOMAS C. WILSON, INC., 21-11 44TH AVENUE, LONG ISLAND CITY 1, N. Y.

WILSON

TW-739

TUBE CLEANERS • TUBE EXPANDERS

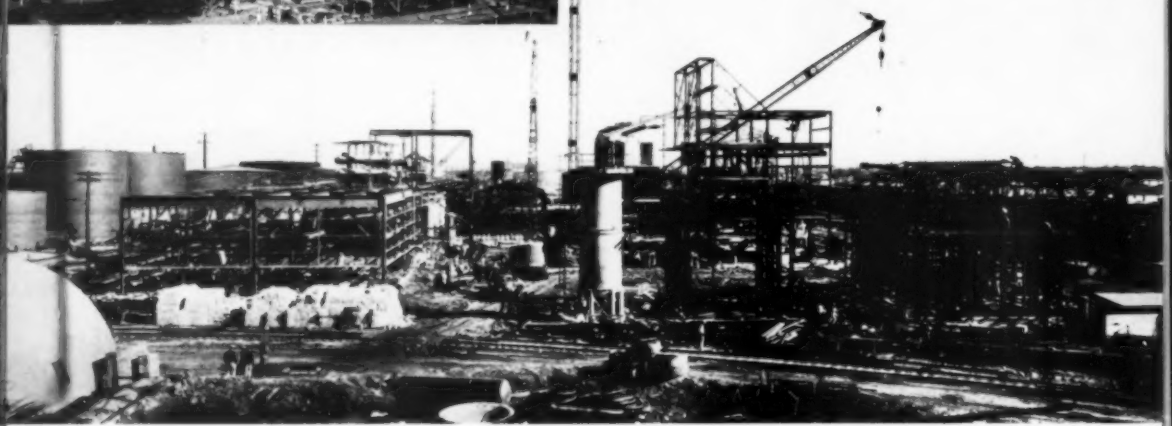


This 3-stage crude distillation unit, essentially a duplicate of one built for the same refiner in 1940, is but one of 18 crude units now in process of design, engineering, fabrication, or construction.

FOSTER WHEELER CORPORATION

165 BROADWAY, NEW YORK 6, NEW YORK

complete lube oil plant
dewaxed oil production: 8000 bbls/day



Three major process units, all built by Foster Wheeler, are involved in the refining sequence of this complete Lube oil plant, viz:

Crude Distillation, 2-stage 40,000 bbls/day
(this is one of five for this same refiner);

Furfural Refining, charging capacity 5500 bbls/day;

MEK Benzol Solvent Dewaxing designed for a
maximum dewaxed oil production of 8000 bbls/day

When all three units are in operation, this combination will represent one of the largest Lube oil plants in the world.

FOSTER WHEELER CORPORATION

165 BROADWAY, NEW YORK 6, NEW YORK

THE *Continuous Operation* OF

BROWN FINTUBE SECTIONAL HAIRPIN HEAT EXCHANGERS

without Shutdowns for Servicing

8 ADVANTAGES

BROWN FINTUBE
Sectional Hairpin
HEAT EXCHANGERS

1. Flanged Shell Seal and Flanged Union Head End Assembly.
2. Extreme Adaptability to Meet the Requirements of Changed Duties.
3. No Obsolescence.
4. Easy Inspection and Maintenance
5. Continuous Operation. No Shut Downs for Servicing.
6. Minimum Investment in Replacement Parts.
7. The Brown Resistance Welded Integrally Bonded Fintube.
8. Easily Removed Rear End Cover Plate.

Write today for Bulletin No. 481. It gives full details

PAYS USERS EXTRA DIVIDENDS

● When they're "on line"—heat exchangers are making money with which to pay wages, bonuses, salaries, dividends. When they're down for servicing,—money is going out—not in.

A bank of Brown Fintube Sectional Hairpin Heat Exchangers can be kept in continuous service—on dirty duty—at high efficiency. The bank doesn't have to come off line for servicing. Users simply manifold an extra parallel stream into the bank. Then they can clean, and make whatever repairs are necessary, to first one stream, then another, while the bank is carrying its full rated load, continuously, at a profit. Simple, isn't it?

Let us help you in adapting Brown Fintube Sectional Hairpin Heat Exchangers—with their many outstanding operating and maintenance advantages—to your next heat transfer requirement. The Brown Fintube Company, Elyria, Ohio. Sales engineers in the principal cities.

BROWN FINTUBE
Sectional Hairpin
HEAT EXCHANGERS

RESISTANCE WELDED INTEGRALLY BONDED FINTUBES AND FINTUBE HEAT TRANSFER PRODUCTS

Stays on the Job at elevated Temperatures

Want a stud you can count on for economical service? . . . One that stays on the job for long periods of time, even at elevated temperatures? The Bethlehem continuous-thread stud is your answer.

The continuous-thread stud is ideal for high-temperature bolting applications because it minimizes stress concentrations. There being no point of thread runout, the fatigue or vibration stresses so often encountered in refinery bolting are distributed over the full length of the stud.

Bethlehem continuous-thread studs are precision-made from carbon or alloy steel and are furnished either plain or heat-treated. They come in a complete range of diameters and in any length, with most sizes carried in stock.

Complete details about the continuous-thread stud are available for the asking. Why not put your questions up to the nearest Bethlehem sales office. Or drop a line to us at Bethlehem, Pa.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

★ BETHLEHEM STEEL ★

Continuous-thread studs are a product of Bethlehem's Lebanon, Pa., Plant

Bethlehem supplies every type of Fastening

"A Cottrell Installed by Research Corporation *will reduce catalyst loss to less than one ton per day"*

The through-put capacity of the cracking unit in the oil refinery was 20,000 barrels per day. The engineer from Research Corporation noted the plant arrangement and type of catalyst to be used and was able to recommend a Research Corporation Cottrell that would keep catalyst losses to less than one ton per day. Actually in some plants the Cottrells have, in effecting the above results, recovered as high as 50 to 100 tons of catalyst per day.

Performance like this is the result of over 35 years of experience combined with careful engineering appraisal, attention to details and a remarkably efficient method. These, combined with equipment which gives recoveries of over 99%, are responsible for outstanding records of recovery.

A letter from you to the Research Corporation will bring an informative bulletin describing HOW the Research Corporation Cottrell Electrical Precipitator performs, and HOW it can bring about important savings. Write for your copy today. 20-107

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47 CARBON BLACK PLANTS
200 METALLURGICAL INSTALLATIONS
203 ACID PLANTS • 34 PAPER MILLS
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NATIONAL cast iron
CONDENSING and COOLING SECTIONS

Economy of Design—The unique arrangement of internal fins and swirlers in National Sections makes possible higher transfer rates and lower pressure losses, with resulting savings in pumping costs and space requirements.

Economy of Installation—Compact arrangement provides far greater effective surface within a given area of space. This, together with the savings in surface requirements made possible by internal design, means that far less spray pit area or water box size is required. In certain types of installations National Sections require only one-third the space needed for competitive equipment. Support lugs cast integrally with the sections make them self supporting, so no auxiliary bracing is required, installation cost is kept at a minimum.

Economy of Performance—External design provides for unrestricted flow of water as a film from one section to the next, with a minimum of splashing. National Sections require far less cooling water than other types of cascade coolers. When submerged in a box, their smooth exterior surfaces give little opportunity for the collection of foreign matter, so high performance is maintained for longer periods.

Economy of Maintenance—The corrosion resistance of Cast Iron, under many varied and severe conditions, insures long periods between maintenance shutdowns. Units are divided into many component parallel stacks of sections, so that sections can be replaced easily, and with little "downtime." Complete standardization of National Sections means minimum inventory requirement for spare parts.

These economies in your condensing and cooling installations—and many more—can be yours with National Cast Iron Condensing and Cooling Sections. Let one of our field engineers show you how—without obligation, of course. Write for our catalog CP-16.

NRC

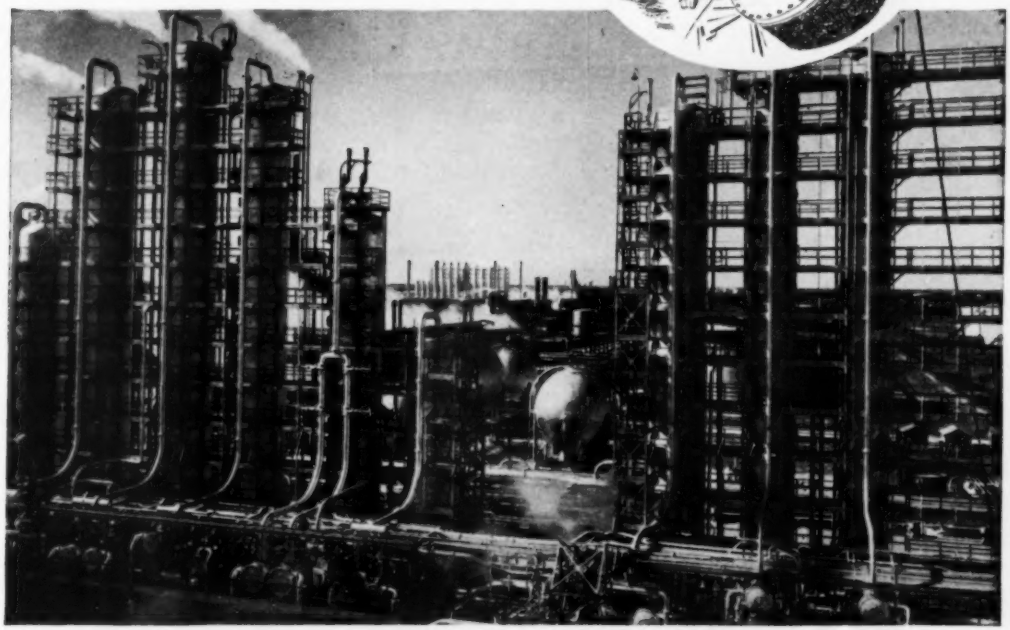
HEAT TRANSFER DIVISION

THE NATIONAL RADIATOR COMPANY

JOHNSTOWN, PENNSYLVANIA

STAINLESS STEEL TOWER INTERNALS SAVE WEIGHT AND GAIN SPACE. Thinner, lighter-weight stainless steel sections simplify fractionating tower structural problems . . . allow space for more efficient manways . . . increase the efficiency of bubble caps and trays. And, smooth, pore-free stainless steel surfaces discourage coking and fouling. ENDURO Stainless and Heat-Resisting Steels currently are helping refiners maintain profitable throughput in cracking stills and tubes, condensers and heat exchangers, still linings, hot oil lines, sludge tanks, swing lines, valves and many more items of equipment.

Enduro-THRIFTY METAL OF 10,000 USES



. . . STRENGTH? YES, AND LIGHT WEIGHT, TOO

High strength—at both frigid and torrid temperatures—traditionally is identified with Republic ENDURO Stainless Steel. It is this property which results in another characteristic of vital importance to the ever-expanding petroleum industry—*light weight.*

Because of its exceptionally high strength-to-weight ratio, ENDURO is used in thin, light-weight sections without loss of strength or durability, and without sacrifice of safety. Today, with refinery operations calling for increasingly enlarged and complex construction, the high strength and fatigue-resistance of stainless steel open vast new design opportunities—unhampered by material limitations.

There are many analyses of ENDURO Stainless and Heat-Resisting Steels, each developed to meet specific requirements of various refinery applications. For further information and factual data, write us:

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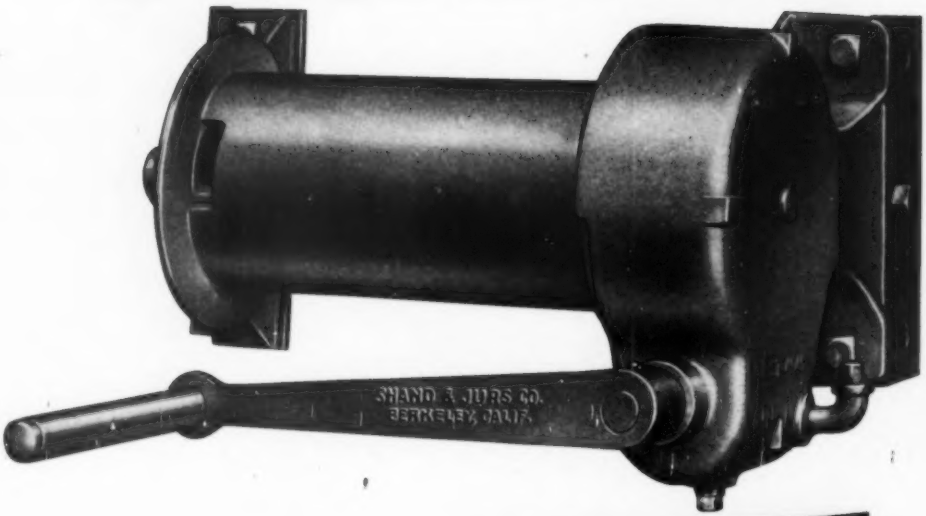
✓ **Check ALL 10 Advantages:** • RUST AND CORROSION-RESISTANCE • HEAT-RESISTANCE • HIGH STRENGTH • NO METALLIC CONTAMINATION • SANITARY SURFACES • EASY TO CLEAN • EYE APPEAL • EASY TO FABRICATE • LONG LIFE • LOW END COST.

A Marvel Among

CABLE WINCHES!



A cheap winch in a strategic location can prove to be very expensive economy. Take a cable winch for handling a swingline inside a storage tank, for instance. Suppose a pawl breaks and the swingline pipe falls to the bottom of the tank. You know what you are in for.

For such important service we have designed and built a quality winch of the worm and ring gear type. When you release the handle, it remains just where you left it. It cannot spin and injure anyone. It cannot drop the swing pipe suddenly. We consider the cable winch one of the most critically important components of our complete swing line equipment. May we send you descriptive literature and prices?

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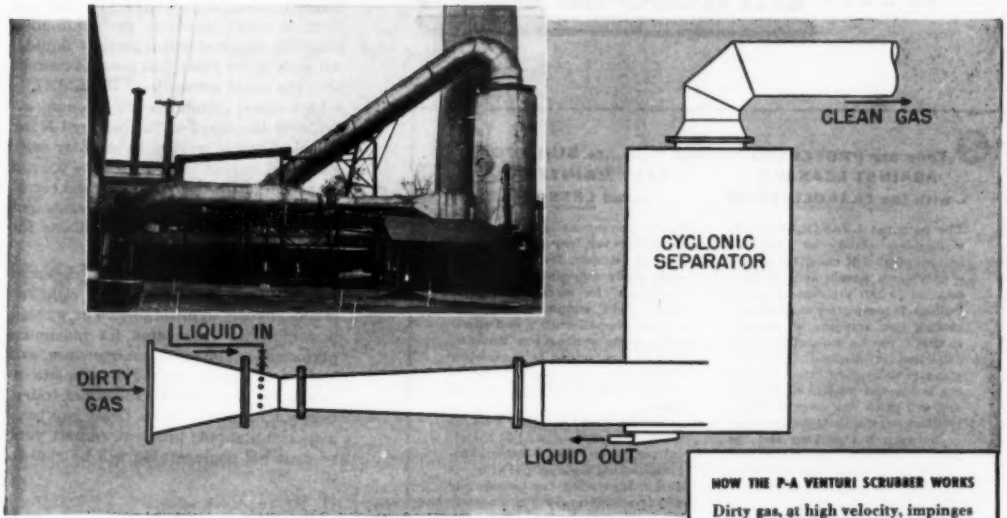
The P-A Venturi Scrubber

(A PEASE-ANTHONY DEVELOPMENT)



HOW THE P-A VENTURI SCRUBBER WORKS

Dirty gas, at high velocity, impinges upon and atomizes a curtain of liquid introduced through jets at the throat of the Venturi. Differential velocities of gas and atomized liquid result in collision of mist or dust particles with liquid droplets. The coalescence of mist or agglomeration of dust resulting from this collision makes simple cyclonic separation possible.

APPLICATIONS: The P-A Venturi Scrubber is a highly effective and economical apparatus for solving such major industrial problems as: SMOKE ABATEMENT · REMOVAL OF DUST AND MIST FROM GASES · RECOVERY OF VALUABLE METALS AND CHEMICALS.

ADVANTAGES: Highly efficient—Assures virtually complete removal even of sub-micron dust and mist.

Low initial cost—The first cost of the P-A Venturi Scrubber is considerably less than other equipment of equivalent performance.

Low Maintenance — Its maintenance cost is less than that of other equipment of equivalent performance.

Low Water Requirement — Requires generally less water (or scrubbing liquid) than other liquid scrubbers.

Can Handle Gas At Any Temperature—Pilot Plant tests show no difficulties even at 1800° F. Actual installations now operating at 700° to 800° F.

More Compact and Lighter—It requires less space and is lighter in weight than other equipment of equivalent performance.

Simple and Safe to Operate and Maintain—Any competent maintenance man can service a P-A Venturi Scrubber. No special skill is needed to repair equipment.

Chemico's engineering background and development facilities combined with Pease-Anthony's experience in gas scrubbing offers highly qualified service in this field.

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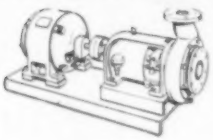


❶ I-R Chemical Pumps are Armored against Corrosion with IRCAMET

These Ingersoll-Rand chemical pumps are built to stand up under the continuous handling of corrosive and abrasive liquids. All parts of the pump that come in contact with the liquid are made of IRCAMET – a high nickel-chromium-molybdenum alloy steel developed exclusively by I-R for chemical pump service. Laboratory tests and years of field experience have proved its exceptional ability to resist the corrosive action of a wide variety of acids and alkalis. Other materials are available for special operating conditions.

In the complete line of I-R chemical pumps, you'll find a unit that's *right* for practically any application . . . a pump that is completely engineered for maximum performance, minimum maintenance, and high operating efficiency. For complete information, write to Ingersoll-Rand, today, asking for Bulletin 7095. Or, if you have a special pumping problem, contact your nearest I-R engineer. He will be glad to help you.

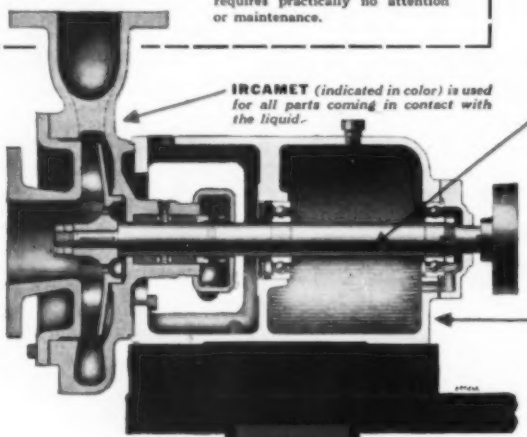
❷ They are PROTECTED AGAINST LEAKAGE —with the LEAKOLLECTOR

The patented LEAKOLLECTOR stuffing-box gland – an exclusive feature of all I-R chemical pumps – provides a simple and effective solution to the problem of pump leakage. It completely encircles the stuffing box, trapping all leakage so that it can be drained away for collection or disposal. The split gland is accurately fitted to both the inside and outside of the box, and will catch any seepage escaping between the shaft and packing, or between the packing and the bore of the box. The LEAKOLLECTOR is easily removed from the shaft for repacking the box.

❸ They are BUILT FOR EASY MAINTENANCE —and LESS OF IT

These pumps are ruggedly constructed to last longer on the job—and the simple design, with all parts easily accessible, means less "time out" for maintenance. The short, rigid stainless-steel shaft prevents impeller whip and eliminates many stuffing box troubles. The suction nozzle is removable, permitting access to the impeller without disturbing the discharge piping.

The CAMERON SHAFT SEAL can be installed on all I-R chemical pumps to replace the conventional stuffing-box packing. It eliminates stuffing-box leakage and requires practically no attention or maintenance.



IRCAMET *(indicated in color) is used for all parts coming in contact with the liquid.*

STAINLESS STEEL SHAFT *provides maximum strength, plus high corrosion resistance.*

PANOFLAM, *a modified, synthetic, resin-base paint, highly resistant to chemical action and to oil and grease, forms a protective coating over the entire unit.*

I-R Chemical Pumps are of the centrifugal type, of simple cradle-mounted design, coupled to the driving motor. They are available in sizes to handle up to 4000 gpm at temperatures to 800° F.

Ingersoll-Rand

CAMERON PUMP DIVISION 362-10

11 BROADWAY, NEW YORK 4, N. Y.

Chlorination...

REDUCES CONDENSER "DOWN-TIME"

When high back-pressure due to slime fouling on condenser water-side surfaces results in excessive down-time and costly plug cleaning, the best "doctor" is chlorination. Here's why:

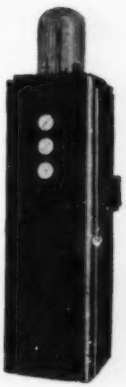
Properly applied chlorination by means of a job-engineered W&T installation is economical. In most cases, the cost of the equipment is saved in the first year.

Chlorination gets at the source of the trouble by killing the micro-organisms that cause slime deposits.

Plug cleaning is eliminated and equipment may be kept on the line thus, in effect increasing station capacity.

Fuel costs are reduced through reduction in average back-pressure.

W&T's more than thirty years' experience in water treatment are always at your call. Write today for a survey of your cooling water system—there's no obligation.



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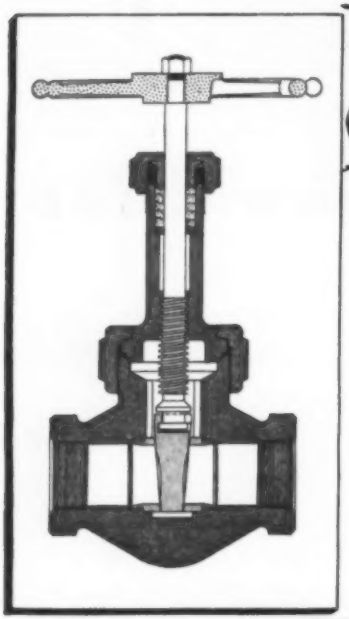
"This time use top quality forged steel 600# gate valves for that hot spot"

"That's easy we'll order VOGT Series 5300" *



Here are valves that will stay on the line longer and require little maintenance year after year because toughness and durability are built into them right from the start.

Series 5300 valves have drop forged steel bodies and bonnets, rolled-in 11½-13% chrome stainless steel seats which can be easily renewed, and solid stainless steel wedges. A ground joint insures tightness between the body and bonnet. The stuffing box can be repacked under pressure when valve is fully open.

Series 5300-F8 valves with 18-8 stainless steel trim and Series 5200 valves with Monel Metal trim are also available.

***Series 5300**

CARBON STEEL / 600 Pounds @ 800° F. \ 2000 Pounds Cold Non-Shock

For 600 pound service • Union Bonnet Ground Joint • Inside Screw Stem • Renewable Seat Rings • Solid Wedge — Slotted Type • 11½-13% Chrome Stainless Steel Trimmings Sizes ¼" to 2" Inclusive.

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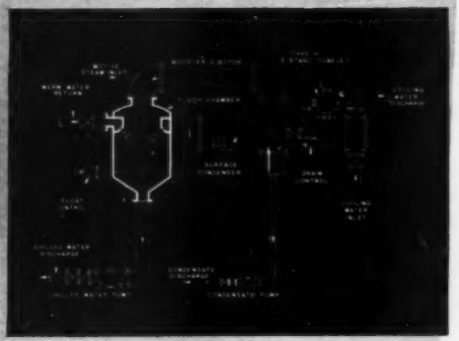

Diagram above and photograph below show C. H. Wheeler Steam Jet Vacuum Refrigeration System employing a Surface Condenser. Low Level Jet and Barometric Jet (Direct Contact) Condensers are also used, depending on the installation requirements.

Steam Jet Vacuum Refrigeration

Lowest Cost—In Every Way

Industrial Steam Jet Vacuum Refrigeration Systems, when compared with mechanical types of refrigeration, are lowest in purchase price, lowest in installation cost, and lowest in maintenance. Operation is simple and service life is long. Water is the refrigerant, thus the hazards of noxious or poisonous ammonia, sulphur dioxide, carbon dioxide, etc., are eliminated. Cooling is by the well-known basic principle of Flash Evaporation, using exhaust or live steam, as fully explained in our Catalog No. 1462, sent on request. C. H. WHEELER Steam Jet Vacuum Refrigeration Systems can be used in the oil refining industry wherever a particular process may require the use of cooling water at temperatures not below 35°F. Examples of such processes are the refrigeration of absorption oil to improve recovery of light hydrocarbons and the refrigeration of cooling water required for deethanizer condensers used in the manufacture of liquefied propane gas. Write for more information about its application to your cooling problem.

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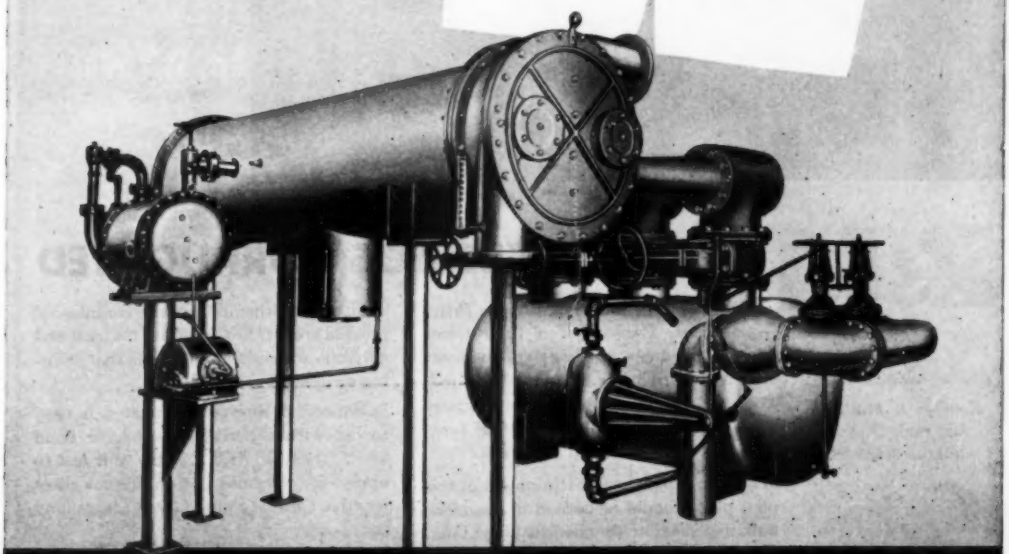

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• *New pilot plant of Pittsburgh Consolidation Coal Company at Library, Pa., sided with "Century" Asbestos Corrugated. Construction by Chemical Plants Division of Blaw-Knox Company, Contractors.*

Built for a LONG life of dependable service

K&M "Century" ASBESTOS CORRUGATED

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This large pilot plant of the Pittsburgh Consolidation Coal Company is the latest unit in one of the most modern research laboratories of its kind. The new building is designed and equipped for the study and development of more efficient coal gasification processes.

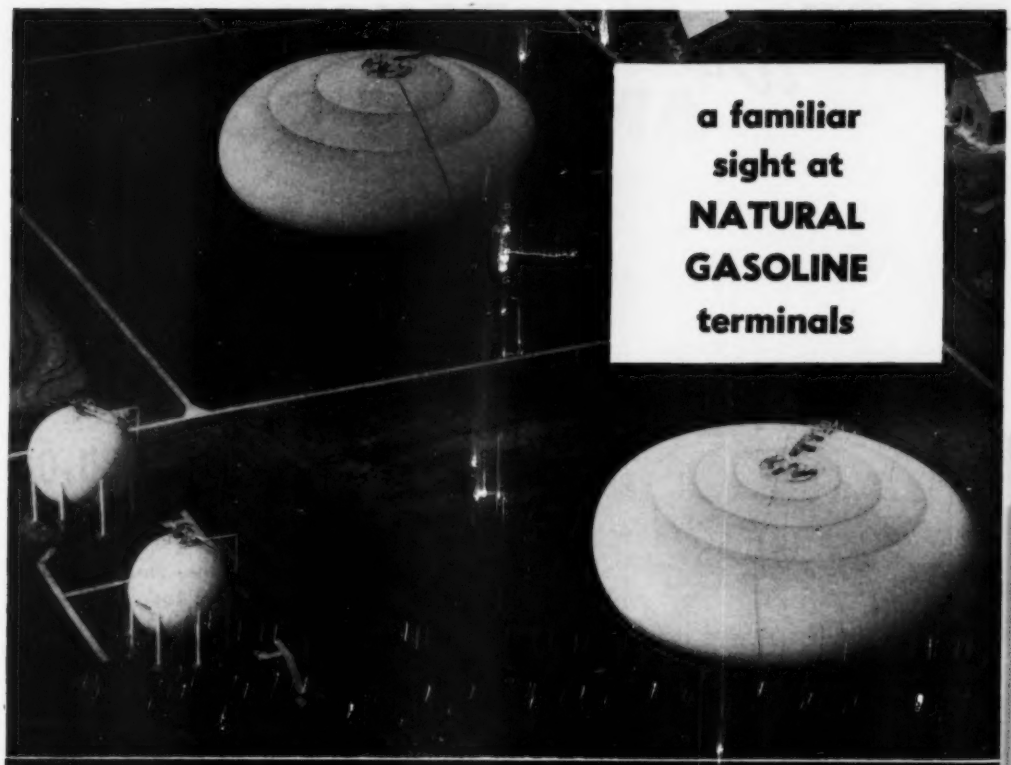
It is fitting that the fine equipment of this pilot plant should be housed in a modern building sided with good-looking, long-lasting K&M "Century" Asbestos Corrugated. This time-proved material is noted for great structural strength and ability to withstand severe commercial usage. It resists fire, weather, rot, rust and galvanic action. And no protective painting or upkeep is needed.

"Century" Asbestos Corrugated is easy to cut with a portable electric or band saw . . . easy to drill . . . easy and *fast* to apply, for it comes in 24 different sheet lengths. Can be re-used even after many years of service.

Write for name of nearest distributor and further particulars. Your inquiry will receive prompt attention.

K&M best in asbestos

KEASBEY & MATTISON
COMPANY • AMBLER • PENNSYLVANIA



HORTONSPHERES and HORTONSPHEROIDS

The above view is just one example of many similar Hortonsphere and Hortonspheroid installations for butane and natural gasoline storage. This particular group of tanks is located at the Warren Petroleum Corporation's Houston terminal.

Some of the reasons why Hortonspheres and Hortonspheroids are so widely used for the storage of volatile liquids are:

. . . *The Hortonsphere* is the logical container for storing butane, butane-propane mixtures, refinery charging stocks, and the more volatile grades of natural gasoline. It is economical to build because its spherical shape utilizes material to the best advantage. The Hortonsphere prevents filling and emptying evaporation losses. The vapor space in a Hortonsphere contains little or no oxygen, which reduces the fire hazard and cuts down corrosion on the inside of the shell. The entire shell of a Hortonsphere is accessible, making it easy to inspect and maintain. Standard sizes are available up to 65 ft. in diam. for pressures up to 50 lbs. per sq. in. and in smaller sizes for pressures as high as 150 lbs.

. . . *The Hortonspheroid* is recommended for storing motor gasoline and natural gasoline requiring pressures from 2½ to 100 lbs. per sq. in. Built in standard capacities up to 120,000 bbls., these efficient pressure storage tanks offer protection from evaporation, a reduction in fire hazard, and require only normal maintenance.

For complete details or quotations on Hortonspheres, Hortonspheroids, or other types of tanks, write our nearest office.

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Philadelphia 3 ..... 1608—1700 Walnut St. Building
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Powell presents a Complete Line of Standard Valves—in Bronze, Iron, Steel, Pure Metals and Special Alloys.* These are of every type and size, and for all pressures and temperatures encountered in the many services for which they are adapted.

But ever-changing methods and processes continually impose new flow control conditions. For these Special Services, Powell Engineers are always ready with Special Designs.

The result is that Powell—and only Powell—makes such a complete line that today there's a Powell Valve specifically adapted to each and every flow control service known to Industry.

Write for information on applications of Powell Valves. And if you have any flow control problems, Powell Engineers will help you solve them.

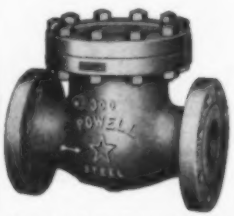

Fig. 3061—Class 300-pound Cast Steel Swing Check Valve with bolted cap and flanged ends. Disc has ample lift to permit full, straightway, unobstructed flow through the valve body.

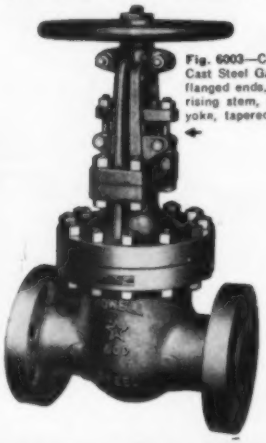

Fig. 6003—Class 600-pound Cast Steel Gate Valve with flanged ends, outside screw rising stem, bolted flanged yoke, tapered solid wedge.

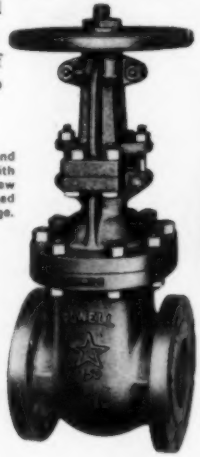

Fig. 1503—Class 150-pound Cast Steel Gate Valve with flanged ends, bolted flanged yoke, outside screw rising stem, tapered solid wedge.

Fig. 1793—Large 125-pound Iron Body Bronze Mounted Gate Valve. Made in sizes 2" to 30", inclusive. Has outside screw rising stem, bolted flanged yoke and tapered solid wedge. Also available in All Iron for process lines.

The Wm. Powell Co., Cincinnati 22, Ohio

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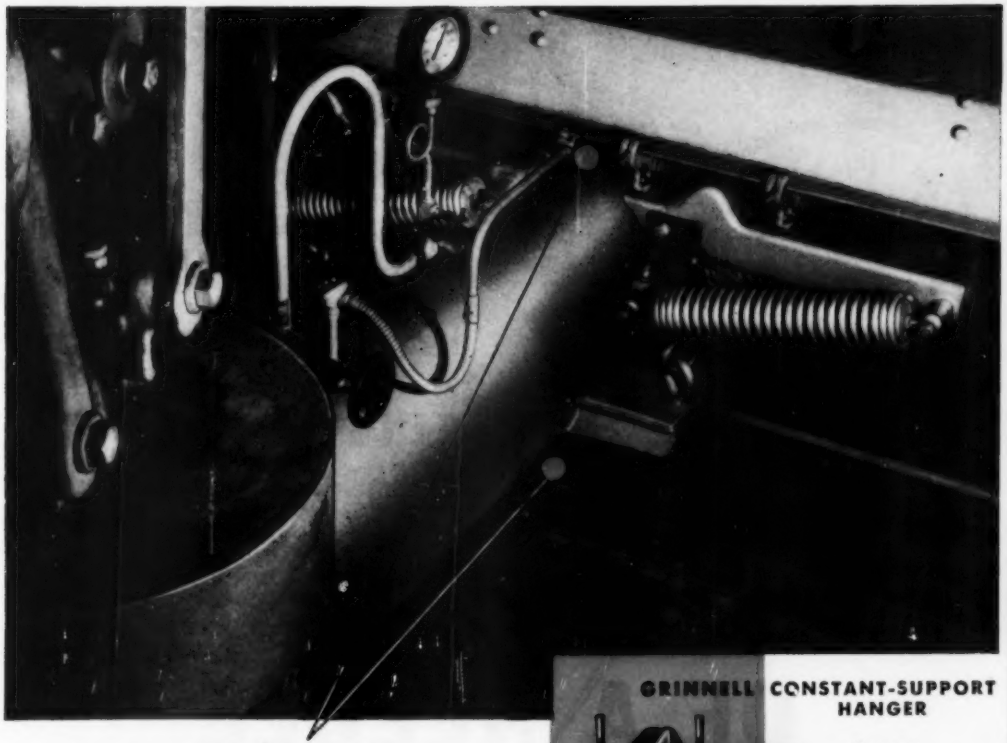
POWELL VALVES



PLAYROOM for a HEAVYWEIGHT

It's a lively chunk of deadweight, this big boiler lead from a superheater outlet at the stop and check valve . . . in the new Southwark station of the Philadelphia Electric Company. It requires "playroom". From its position when cold to its position at 900°F., this piping travels through all three planes — vertical, lateral and longitudinal.

At every point of its travel, the weight of this piping is fully supported by Grinnell Constant-Support Hangers. Yet, because of their compact design, little extra "playroom" need be allowed in which to install the hangers.

Write for the new Grinnell Pipe Hanger Catalog 10-D, containing every pipe hanger, part and accessory, with full instructions for easy selection and correct specification.

GRINNELL CONSTANT-SUPPORT HANGER

the ONLY constant-support pipe hanger

- provides constant support to piping subject to vertical movement — in all "hot" and "cold" positions.
- maintains full safety factor in supporting high temperature, high pressure piping.
- non-resonant and energy absorbing.
- mass-produced from standard precision parts.
- individually calibrated for each installation.
- load-adjustment features incorporated into design.
- three models meet entire range of load-travel specifications.
- minimum headroom required.

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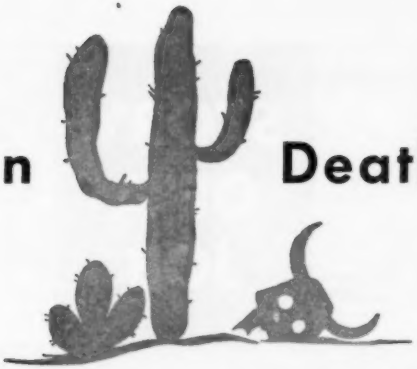

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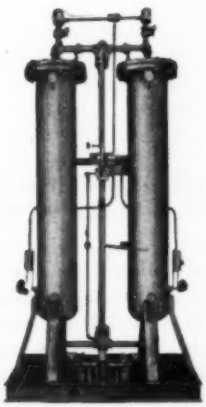

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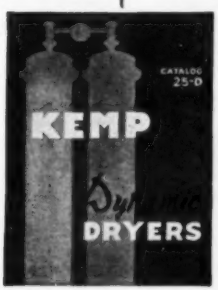

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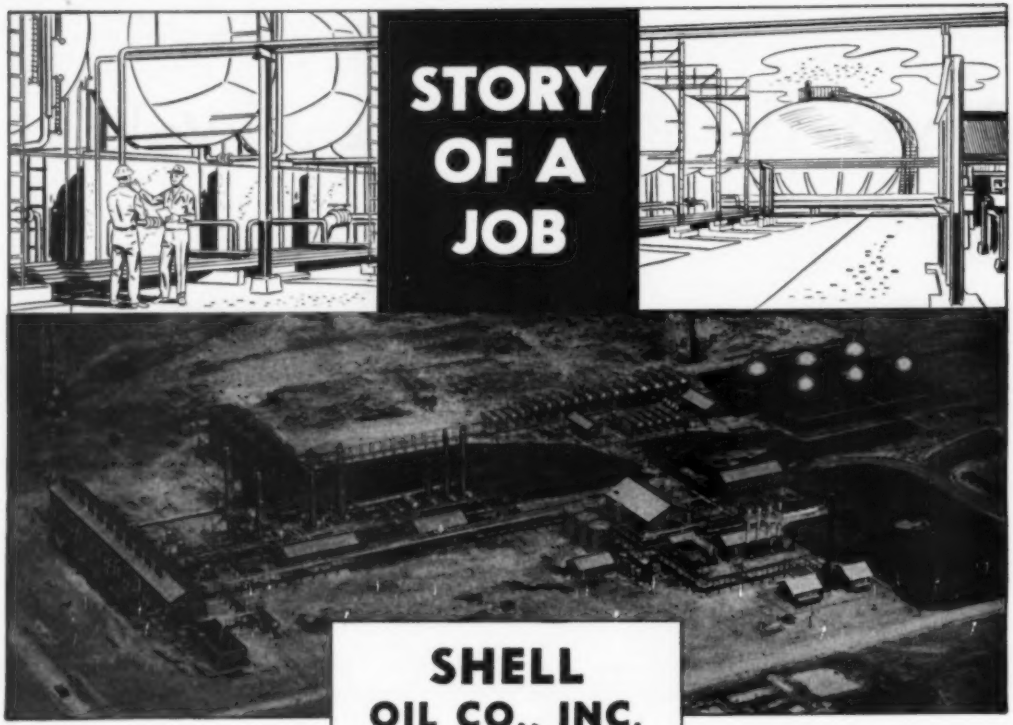

STORY OF A JOB

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The best laid plans of men are frequently subjected to change by various influencing circumstances. Such was the case at Shell Oil Company's TXL Gasoline Plant near Odessa, Texas. Brown & Root, Inc., was awarded the contract to build a 30,000 mcf gasoline plant for Shell. During construction, new field development made it necessary to increase the throughput to 45,000 mcf. Shortly after completion, still further demands necessitated tripling the original capacity to handle 90,000 mcf!

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PETROLEUM
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VOLUME 28, NO. 5 MAY, 1948

The LOOK BOX

Still Another Pioneer Gone

By RAY L. DUDLEY

THE death on March 25 of Ross Shaw Sterling, president of Sterling Oil & Refining Company, and one of the founders of the Humble Oil & Refining Company, has removed still another of the colorful pioneers in Southwestern oil.

It is difficult to write of him impersonally because he was such a close friend. The early days of this publication, and of the Humble Oil & Refining Company, then a great independent oil company, coincided and we had much in common. At that time Mr. Sterling was president of Humble Oil Company which was the forebear of the present Humble Oil & Refining Company. Later he became chairman of the board and then retired to his other businesses, which were numerous. He was extensively interested in rice, in banking, in irrigation (one day he confided to us that he had grubstaked someone and as a result held an interest in a profitable gold mine). At one time he was a heavy owner of real estate in Houston, and principal owner of the morning paper in Houston.

He then became interested in politics, was appointed chairman of the Texas Highway Commission, and did such a fine job that he was elected governor. Then came the dark days of the depression, with Governor Sterling giving all his attention to affairs of the state. His personal interests suffered acutely and he lost much of what he had accumulated. It was during the depression that he started a comeback, through the organization of Sterling Oil & Refining Company. His new company had the well wishes of a host of friends and was very successful in developing production.

But it was for Ross Sterling the man, rather than the oil man, the business man, the statesman, that he was held in greatest affection by his friends. He was generous to a fault. No one but Ross Sterling, and possibly his widow, will ever know of the numberless instances of where he helped young people, because he had little to say about what he had done. But we know of many, because we were closely associated with him in some of his business enterprises, and we ourselves are proud to say that Ross Sterling helped us once when help was desperately needed.

His life was filled with service to his fellow man. He was for years connected with the Houston Port Commission, and at his death was chairman of the Board of the Hermann Hospital Estate, a charitable institution which is heavily engaged in the operation of hospitals in Houston.

We shall miss him, and so will many another person who knew him and loved him.

Willingness To Pay

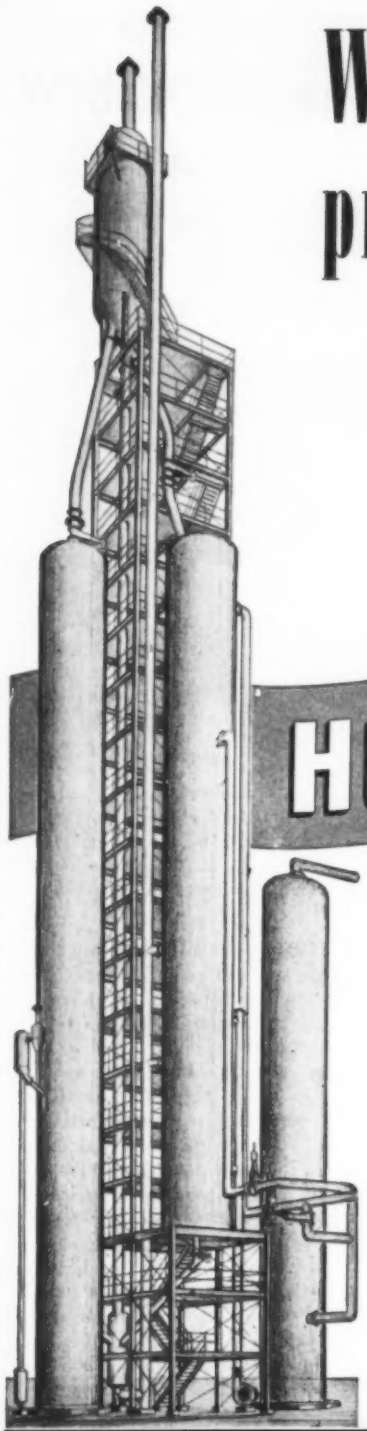
EVERYONE agrees that economy in government is important. But the *achievement of economy* requires that our *belief in economy* be directed effectively against the particular pressures that always will be found in support of particular expenditures. In other words, as the Committee for Economic Development suggests, every proposal that would expand government functions should pass the test of society's willingness-to-pay for it in taxes.

Conservation In Oil Utilization

CONSERVATION of our resources involves much more than the processing of all flare gas. The efficient utilization of petroleum products is equally important, even though it does not seem to have equal interest for our legislators.

The Natural Gasoline Association of America made a recommendation in February, 1947, that the present ASTM D439-40T tentative specification for gasolines be revised from 13.5 maximum Reid vapor pressure to 15 pounds maximum Rvp. The recommendation was based on the Nowata road tests which indicated rather clearly that the fuel vapor pressure tolerance of late model passenger cars is considerably greater than the present 13.5 maximum.

In response to this recommendation, both the American Society for Testing Materials and the Society of Automotive Engineers have carried on extensive discussions and committee actions, and



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the proposal is currently being subjected to advisory balloting by committees of each society.

Reactions have been quite favorable until recently. Some doubts have now been expressed by representatives of the automobile industry in regard to the effect on trucks, many of which are fueled at retail filling stations. The NGAA in turn has sent a special sub-committee to Detroit to discuss the proposal with engineers in several automotive companies. It was found that the objections were base on interpretations of service reports on trucks using 11 to 13-pound-Rvp, winter gasolines and 8 to 9-Rvp summer gasolines. Few test data are available on this special vapor lock problem.

Present indications are that for the recommendation to be adopted into the ASTM specifications, it will be necessary to overcome the objections raised. A number of companies have assisted the studies by making available their data. Notable contributors are Phillips Petroleum Company, which has supplied atmospheric temperature analyses and comparative vapor lock analyses between winter and summer gasolines, and Sun Oil Company which has supplied limited truck test data on 15-pound gasoline. General Motors is currently assisting by running limited heavy duty truck tests on their proving grounds using 15-pound gasoline.

It is too early to predict the outcome, but it is much to be desired that the problems be satisfactorily worked out. A 15-pound winter gasoline specification will provide a large potential outlet for butanes in motor fuel blending, the premium price outlet for such products. Conservationists, too, should be gratified if this additional volume of butane can be utilized in gasolines, thus helping to extend the precious reserve of liquid fuels so important to our transportation systems.

Decentralization Invites Initiative

SUCCESS of Oil Progress Day, observed October 14 last year, convinced the Oil Industry Information Committee that its program of public relations has reached the point where it would best be decentralized. Local oil men and regional associations, last October "carried the ball," and successfully; so in line with the original plans adopted at the beginning of the program, decentralization will now go forward.

Thus the local men will assume greater responsibility in the adaptation of the program for their areas. National activities in this manner will be better accommodated to the individual needs of each section of the country. Also individual initiative will be encouraged more than was possible under central office operation and the net result should be development of many constructive ideas in the field.

National direction, therefore, will change from detailed to general supervision. "Each field representative shall be instructed to seek the approval, etc. of the district chairman on all projects suggested by OIIC, and lacking approval he shall not promote any project," an announcement reads. Thus the matter pretty well rests in local hands.

No change in the basic objectives of the industry program is contempleted, it was emphasized.

Public Relations In the West

STANDARD Oil Company of California deserves a pat on the back for the public relations job it has done in locating its new tank farm near Puget Sound. Better make it a couple of pats because 1) the company had the good sense to build its tank farm in the way it did and 2) it is buying advertising space to remind the public what it has done. Here's the story:

The new tankage, one of the largest in the West, is set in a clearing on a densely wooded hillside above the Point Wells (near Seattle, Wash.) plant and will be completely hidden by a ring of fir trees from view of passersby on a public road nearby. The tanks are to be painted green to blend with their surroundings, an innovation in such installations. Scenic beauty thus will remain unmarred.

Then there's another mighty good angle to the story: Actually the six tanks aren't needed under normal weather and shipping conditions; but the company is spending $1 million to make certain there will be enough oil on hand to meet any emergency spell of unusually bad weather, this so that the homes of the people in the area served always will be warm. John Public shouldn't forget that either.

Jobs and Skills

THE individual worker cannot be held solely responsible for keeping himself employed at all times under modern economic conditions, says the Committee for Economic Development. But if he wants employment, it adds, he does have the responsibility of making the most effective use of the opportunities available.

For a job-holder this means giving a good day's work for a good day's pay, and steady effort to improve his competence.

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The basic design of the Elliott Type YR steam turbines permits modifications to suit any application, while still retaining standard normal wearing parts, including bearings, packing rings, governor parts, valves, etc.

For instance, the heavy-duty, high back-pressure turbine, illustrated, uses standard wearing parts with its extra heavy casing and enlarged packing glands. It also still retains the outstanding features of the standard YR turbine such as:

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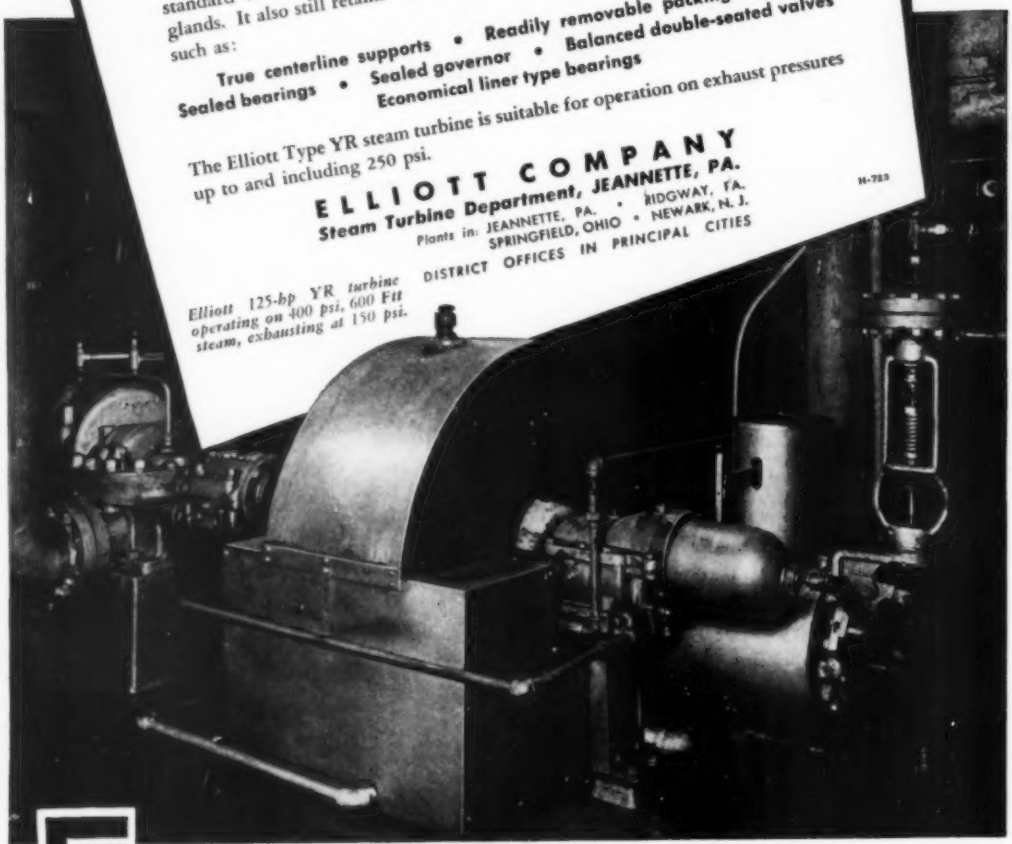


Elliott 125-hp YR turbine operating on 400 psi, 600 Ftt steam, exhausting at 150 psi.

Elliott MECHANICAL DRIVE Turbines

Trend of the times

Talks with men on street needed if American system of free enterprise is saved

RICHARD WAGNER
President, The Chicago Corporation, Chicago

C. R. Williams, vice president, and Richard Wagner, president, The Chicago Corporation, at the NGAA 28th annual convention, held last month in Fort Worth. Wagner addressed the convention on economic and political trends and their effect on the national economy. His "Trends of the Times" appears herewith.

THE real problems facing business today are the ever increasing trend toward socialism and big government, with a large part of its agents and personnel woefully ignorant of what makes the wheels go round.

But first, let's take a look at the short-term trend in business and industry. It is quite apparent that a broad adjustment has been underway for several months. The past three years were the biggest on record, not only as to total tonnage of goods and raw materials produced, but as to people employed, profits, wages paid, and national income. That's an interesting fact when you remember how government experts and the "economizers" outside of government offices expected a serious unemployment problem and business letdown immediately following the war. These groups completely overlooked the huge deferred demand, the tremendous unsatisfied requirements of our people, which had been built up during the war years, their needs for wearing apparel, more food for the table, housing, autos, radios, washing machines and a host of other products. Shortages immediately developed.

After a while when the economy didn't act the way they thought it should, those who had been wrong in the first instance changed their tune. They decided we were going to have an ever expanding economy, but that we must have a lot of new controls to make it work. Along with these government opportunists a number of people generally got the idea that 1947 and 1948 were normal years of a new era. In the mean time the deferred demand was being satisfied, the shortages were being overcome, and business was faced with the necessity of recognizing that total production would have to recede from the peaks it had attained.

The consumer goods industries were the first to sense that we were going from a sellers market into a buyers market. Some of the heavy industries then began to feel it, and it now seems sure that before this year is ended the steel industry, in which the greatest shortages have existed, will be in balance and able once more to serve customer's needs. This is not a situation that need frighten us at all. It does mean that we will have to cut our costs down in order to have our business healthy, it does mean that we will have to make greater efforts to sell our products, to increase efficiency, and to render better service.

The Federal Reserve index of production for the last prewar year, 1940, was about 125. Last year it was almost 200. Recently it has dropped to about 186. Since 1940 we have had an increase in population of about 11 percent. Therefore, you can add approximately 11 percent to the 1940 production index which would bring it up to approximately 140. Add another moderate increase to take care of the normal growth factor in our economy and a present theoretical normal for the production index could be between 150 and 160. That's substantially higher that we ever had in any prewar year. Now, obviously a drop from 200 to 160 would be a 20 percent drop in total volume of business. Accompanying such a drop will be some lessening of employment not only because fewer people are needed to produce at that level of productivity, but because there may be some hope of increase in efficiency of labor. However, there have been employed in our economy a large number of older persons and members of families who do not ordinarily work steadily. Therefore, we can conclude that such a decline in total output need not constitute a major economic problem if we shape our business practices and policies accordingly and if government shapes its fiscal policies accordingly.

Business under normal conditions is always seasonal and 1949 has been quite seasonal thus far. The usual seasonal characteristics are for a considerable letdown in January, February, and part of March with some improvement as Easter approaches, further improvement through the summer and fall months, an increase in retail sales in the last quarter, but a drop in production in that period. Business this year has followed and probably will continue to follow seasonal trends, but I believe that there will be some further adjustment downward to conform to the pattern of total production previously mentioned.

Whether or not subsequent years are good or bad will depend very largely upon political trends and social trends about which I am not optimistic. We have had too much tampering with our economic machinery and too many new proposals for further inroads upon sound American economic principles.

In a sense business, finance, and economics are everyone's business. Yet it is safe to say that a majority of the people in this country have no understanding of the economic functions of business and industry. As a result they are prey for the pink propagandist, who pictures a business man as a fat-head, squeezing the life savings out of widows and orphans, but letting just a little "trickle down" to his workers so they can continue to slave in his treadmills. And don't forget that "trickle down" line was in the President's message to Congress last January.

Let me read from a recent report:

"There is no royal road to economic stability by the route of informed judgment, to say nothing of the route of political vagaries. But there is a slow and painful road, through the process of bringing the best available thought and knowledge to bear upon the problem, and through the willingness of those who exercise political and economic power to be guided by such thought."

And in the same report:

"The principal limitations are imposed by the fact that no collection of data can comprehend the enormous variety of economic relationships and no tech-

niques of analysis can forecast with assurance the actions and reactions of a free people."

These appeared in the third annual report to the President by his Council of Economic Advisers, December, 1948.

Yet a majority of that Council supported the President's "Economic Stability Bill of 1949." That bill and its program is socialistic. It is based upon a complete misconception of the economic functioss of American business and industry. If enacted it would weaken economic incentives, prevent normal price adjustments, and then cause the government to do the things private enterprise had been prevented from doing. It is the straight path to collectivism.

"Stop, Look and Listen"

Why doesn't the Council examine the record and avoid the grevious errors of other countries? Did it advise against rent control? Of course not, yet the record of rent control in France stands out like a beacon warning on a treacherous reef. The record of social medicine in Germany, where it has been in vogue since the time of Bismarck, refutes all its advocates claim for it. The record of social planning of many hues in England literally shrieks "Stop, look and listen." Did the Economic Advisers tell their "master" that taxes had reached the point of diminishing returns and threatened to accelerate the decline already impending? No, they approved tax increases and they just shaped their course to the very political vagaries they decried in their report.

We have really gone a dangerous distance toward the elimination of sound ideals, yes, toward the extinction of the kind of individual freedom upon which this nation was conceived. This is in no sense a partisan problem. The schemes of the so-called planners and many of the laws already on the books are but contraceptives which will destroy the fruitfulness of our national economy. The insidious boring from within and the poisonous injection of false propaganda by "professional" reds against our sound American institutions, the species reasoning of men in high government places together with the burden of two wars in our time have brought us to the brink of socialism now!

Socialism, communism, fascism, and what has become known in this country as "social democracy" or the "welfare state" are all forms of collectivism in which individual liberties are submerged and the state becomes supreme. What difference is there between a monarch and his nobles or a dictator and his party leaders? In either case the individual members of society take orders instead of making decisions, and are regarded as of secondary importance. Collectivism is not liberalism. It is the worst kind of reaction—reaction to serfdom and bondage. The greatest liberal idea ever effectively introduced into human relations was the concept of the freedom and the dignity of the individual which created this nation.

The most serious step we took toward socialism was the abandonment of the gold standard in 1933. That opened the way for the orgy of federal and state spending which has been sapping our economy ever since. When a people cannot redeem their currency, there is no check on extravagance of the sovereign. Never in the history of monetary economics has any nation with an irredeemable currency been able to avoid collapse of government credit. This nation has had an irredeemable currency since 1933, and we are headed for a collapse of government credit unless before long we resume free gold redemption. If we haven't the courage to take this vital step, collapse of government credit is ultimately certain. That is the shortest cut to the full-fledged socialistic or communistic state.

Our 1950 fiscal year budget is $44 billion. If we recede to a level of 160 for production indexes, it is quite apparent that taxes will not produce nearly enough to meet such a budget. Yet, the President has already told Congress that the next budget will be higher. Facing deficits, the government will propose bigger and better gifts to other countries hoping to stimulate our industries and our employment even at the expense of giving away irreplaceable raw materials. Then we will have more federal spending to "prime the pump." Naturally that means much greater deficits, so next we will increase government borrowings from banks. A probable step to follow will be lowering the theoretical dollar values in terms of gold. Finally after several rounds of this process, people will lose confidence in the value of money, will resort to panicky buying of commodities, natural resources, land, stocks, and anything in general which is not limited in terms of dollars. Prices will skyrocket in disastrous inflation, and we will discover that we are no different than many other nations which have gone down the same road.

When we hit the skids is there a beneficent nation anywhere in the world which will give us a Marshall Plan or do anything to save us from our own folly? Someone will undoubtedly tell you this statement is wrong because the dollar stands so high in the world today. Of course it does, but only because we are giving it away and are willing to take it back in exchange for our precious raw materials and products. We cannot long afford this beneficence unless we get in return materials and goods which we do not produce.

Trend in Taxation

In 1916 all Federal taxes were $708 million. They rose sharply because of World War I to a peak in 1920 of $5.8 billion and then through the practice of economy in government they dropped by 1923 to less than $3.5 billion. In the early depression years federal taxes dropped to a low of $1.7 billion. Then in 1933 we went off the gold redemption standard. Since that time with hardly a break federal taxes have risen steeply to a peak of $40 billion, and the President wants $44 billion.

In 1916 all local taxes other than state taxes totaled $1.5 billion. Ever since with only a lull in 1930 to 1932 these local taxes have risen until now they total $6 billion annually, and the trend is still upward.

State taxes in 1916 for all the 48 states in the country amounted to a total of $364 million. By 1948 they had risen to $6.8 billion. Thus at this time state and local taxes combined amount to almost $13 billion a year. And the end is not yet.

All taxing bodies in the country in 1916 collected $2.6 billion. In 1933, the first year under the irredeemable currency conditions, all forms of taxes totaled $7.5 billion or less than three times in 1916. Since then total taxes have risen to where they are above $50 billion. Assuming approximately 45 million families, the average cost of taxation per family is now over $1100 a year.

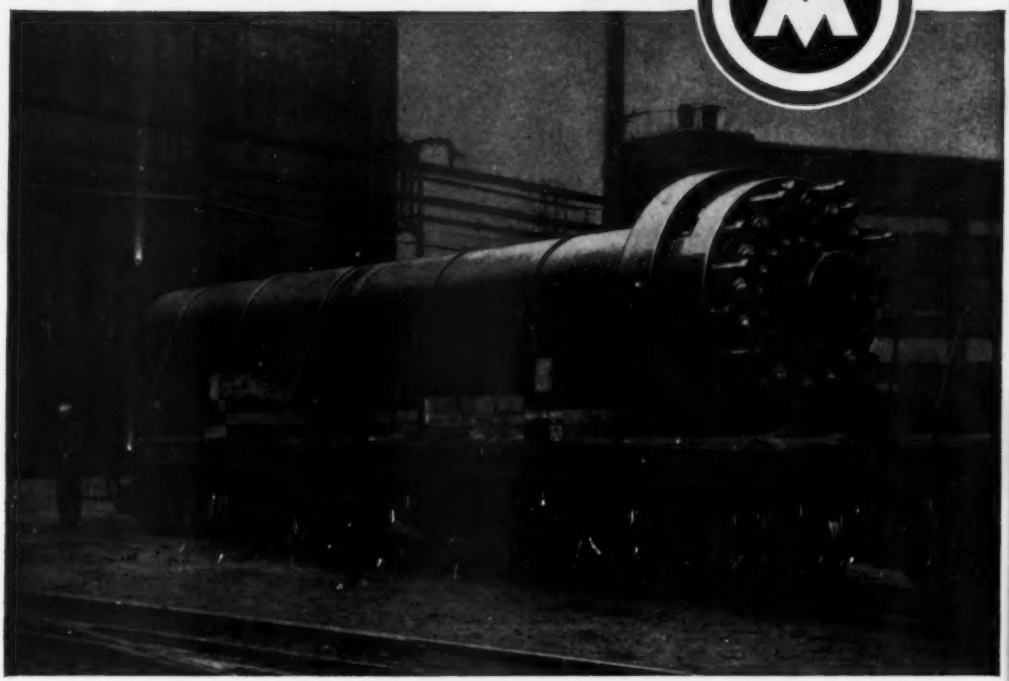
A large part of the money has been and is being used for purposes which are inherently socialistic—subsidies, power projects, handouts, Navajo rehabilitation, competition with business and housing all of which eat at the heart of our productive plant and are causing progress to retrograde and decay. Incidentally, 18 to 20 million persons or one out of every seven is dependent upon government for his livelihood. In addition government checks go out each month to almost 10,000,000 other persons.

The difficulty with all of these schemes is that they are calculated to appeal to the selfish instincts of various groups in our nation who think they are getting or are going to get something for nothing.

Let's take a brief look at socialized medicine and free hospitalization. Germany has had it since the time of Bismarch and what has it done for German health? While recent figures are not available, in the last year, 1933, in which comparisons could be made average man-days lost in Germany because of illness were 28. In this country last year we had only an average of 6½ man-days lost because of illness and we have not had socialized medicine. We do have a lot of free clinics and free hospitalization, but these are based upon private voluntary efforts. If we are to regiment the doctors, why not lawyers, accountants, teachers, and the rest of the professional group? Socialized medicine in France is shot through with graft and corruption.

Rent control, at first blush, appeals to the average person when it is based upon the theory of keeping rents down for the boys who came back from the war, but a close examination of the facts will convince any thinking person that to impose restrictions upon what can be charged for the use of privately owned property, or any attempt, to fix prices, requires the repeal of the law of supply and demand. Natural laws cannot successfully be set aside any more than we can regulate by statute what people think or how tall they may grow.

France has had rent control since World War I. The result has been that practically no building of rentable units has been undertaken in France since the law was put into force. On the other hand, there are no vacancies in France, but there are also no buyers of property. No one can afford to own rentable property. As a consequence, in this enlightened age, in Paris 82 percent of the population is without bath or shower facilities, more than half of the Paris population have no lavatories on the premises and more than 20 percent do not even have running water. French government inspectors state that only one in six of existing buildings is considered in satisfactory condition. This is a startling example of what happens when government tampers with economic forces. The only remedy for a housing shortage is more rentable units. They are built only when the builder can afford to pay taxes, costs, and still have a reasonable return on his investment. If the government builds them, the people have to foot the bill anyway.



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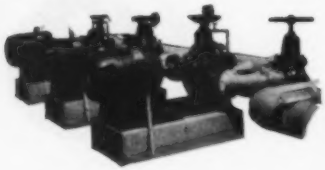


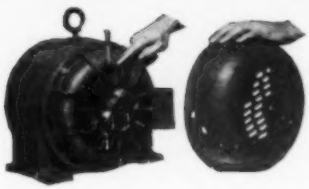
How do

ON MOTORS

Q. As applied to a motor, what does "explosion-proof" actually mean?

1) *That the motor's operation is not affected by external nearby explosions?*
2) *That gastight construction prevents entry of gas or vapors that might explode inside the motor?*
3) *That the motor's enclosure withstands internal explosion and keeps sparks from escaping outside?*

A. An explosion-proof motor (Class I Group D) has an enclosure which will withstand an explosion of a specified gas or vapor which may occur within it, and prevent resulting sparks, flashes, or explosions from igniting the specified gas or vapor surrounding the motor. G-E makes the most complete line of motors tested and listed by UL for hazardous locations in refinery service—in some cases, the only ones so listed. See Bulletin GEA-4131.



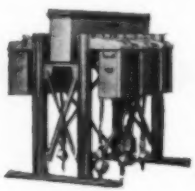
Q. What's the newest development in corrosion resistance for refinery motors?

1) *A newly developed paint immune to acids and alkalies?*
2) *A new type of cooling fan?*
3) *A special grease lubricant for ball-bearings?*

A. It's G-E's new Textolite® corrosion-resistant cooling fan, now supplied in all Tri-Clad® totally enclosed fan-cooled motors in ratings from 1 to 15 hp. Added to Tri-Clad's corrosion-resistant cast-iron enclosure, the new fan now makes these standard, off-the-shelf motors available for refinery service regardless of the acids and alkalies that may be encountered. It's nonsparking, too, and tested and listed by UL for use in explosion-proof motors for hazardous areas Class I Group D, and Class II Groups E, F, and G. Send for Bulletin GEA-4400 on Tri-Clad totally enclosed motors.

Q. If you were placing low-voltage control in a hazardous or semi-hazardous location, what equipment would you specify?

1) *Separate units and wall-mount?*
2) *Circuit breakers separate from starters?*
3) *A factory-assembled group unit?*



A. The convenient, time-saving way is to specify a racked-up assembly of G-E combination starters and breakers designed especially for indoor or outdoor refinery use. It's a standard, factory-built arrangement, with all control units mounted on a self-supporting framework. Available are corrosion-resisting, oil-immersed, and air-break explosion-proof types, the last two for Class I, Group D locations. Bulletin GEA-3541 gives data on oil-immersed starters.

GENERAL ELECTRIC

you rate AND CONTROL?

Q. For what reason would you specify a motor control center?

1) *It saves space?*
2) *It simplifies future expansion?*
3) *Easy installation and maintenance?*

A. All three features characterize the new G-E motor control center, with which you can plan the right combination for your plant's needs. Compact, self-enclosed starting units (in four size ranges, from NEMA size 1 to 4, inclusive) fit interchangeably within vertical sections. Front-connected wiring simplifies installation, changes and maintenance. Sections can be placed back to back or against a wall to utilize available plant space. Bulletin GEA-4979 describes the new G-E motor control center.

Q. When you want to combine high-voltage motor control with short-circuit protection in a semi-hazardous area, what do you do?

1) *Order circuit breakers magnetic starters, and overload relays separately?*
2) *Specify group-assembled controllers as one unit?*
3) *Install magnetic starters and provide for short-circuit protection by means of separate safety switches?*

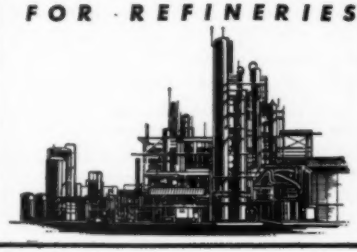
A. You would do best by specifying high-interrupting capacity G-E refinery-type Limitamp controllers, with sealed current limiting fuses which serve both as fuses and disconnect switches. Contactors are oil immersed or in explosion-proof cases. These compact units are completely wired ready to be quickly and inexpensively installed. They are furnished as single units or as a complete group of several units, including incoming oil-circuit breakers and transformer feeders. Check Bulletins GEA-4247 and GEA-3660.

G.E. MAKES DOUBLY SURE YOU GET THE RIGHT ELECTRIC EQUIPMENT

Bring your questions on the selection of motors and control to General Electric. For G.E., over the years, has developed the most complete line of electric equipment to meet specialized refinery needs. What's more—to make doubly sure your selection is correct—G.E. teams up two or more engineers to advise you. Specialists who know their particular lines of electric equipment inside out work hand in hand with an "industry" man who is thoroughly at home with refinery practice and electrical needs. With their pooled knowledge and experience to draw on, you're certain to meet your requirements practically, economically. Check your nearest G-E office and help yourself to this "extra." For more information on motors and control, send in the coupon.

MOTORS AND CONTROL

FOR REFINERIES



General Electric Company, Section F 654-87
Apparatus Department, Schenectady 5, N. Y.

Please send me the following information on G-E motors and control for refineries.

.....*GEA-4131—Motors and control for hazardous locations*
.....*GEA-3541—Oil-immersed starters*
.....*GEA-4400—Tri-Clad totally enclosed fan-cooled motors*
.....*GEA-3660—Limitamp controllers with oil-immersed contactors*
.....*GEA-4247—Limitamp controllers with air-break contactors*
.....*GEA-4979—Motor control center*

Name.....
Company.....
Address.....
City.....State.....

Seek Increasing Power

Some of the provisions of laws which have been enacted since 1933 are not without basic merit, but when they interfere with the normal functioning of the economy they do harm which far outweighs any momentary good which was intended. It is strange, but nevertheless true, when a nation runs into difficulties the people demand action by their governments, any action, they seldom know what. Those in government take actions they hope will correct a momentary distress or difficulty, but usually without regard for the ultimate effect of such actions upon the economy. Once in force these measures become rigid and the persons who are employed by the government to carry them out resist every attempt to change or amend or abolish the rules in favor of a sound economy. Instead they lobby for increasing power over the lives and actions of the people not necessarily because they are all socialistically inclined, but because it is a common human trait to seek more power. As a result for a number of years we have been adding more and more experiments, restrictions, and controls which in the aggregate have gone a long way toward the establishment of state socialism. The process is relatively gradual—like a slow cancer.

The Real Job

Constant repetition of these matters among those of us who have some understanding of them has been of no avail. The real job to be done is to try to appeal to the good sound common sense of the people in this country who do not belong to business associations, chambers of commerce and Rotary clubs. The professional communists and socialists do not appear before large special groups nor do they appeal to the public through national advertising. They work in what they call cells—small groups among the workers, professional men, educators, and the like.

I would impress every one of you with the realities of the danger confronting us—with the necessity for each one of us to take time out in an effort to present the truth of these matters to small groups in the fields of labor, professions, and in the homes, right down at the grass roots. If we can present the true picture of business and industry and true economic facts at that level, we may hope to succeed in stopping the trend which can only lead to disaster.

Despite propaganda to the contrary over 80 percent of all personal incomes in 1948 went to those earning less than $5000 a year, over 70 percent of the combined total of all dividends, rents, and interest paid to individuals in 1948 was paid to persons earning gross incomes of less than $5000 a year. Such facts will stop the spread of the belief that some sinister small group gets all the income and profits. The majority ownership of corporations in this country is in the hands of many millions of people with moderate incomes. It is vital for the people to know that if you "knock off" $4 billion of business profits by additional taxation, you must necessarily eliminate a like amount of expenditures for new plants and equipment which are the job creative forces in our economy, and as a result you will probably eliminate several million jobs. The people should learn that the profits of all corporations last year, the biggest year on record, were only 9 percent of the total national income. If all those profits were eliminated and we could continue doing business, which is to be doubted, no great increase could be paid to labor and employes generally.

The lowest wage earners among the people need food and clothing and housing and the real culprits who are preventing these necessities from trickling down to them are the government exponents of the maintenance of high farm prices and the feather-bedding and slow-down rules of labor unions which prevent workers from doing an honest day's work. During the past three years, business, and I assume those who conduct business are meant as the privileged few, has invested in new plant and facilities an amount approximately equal to all of its earnings before deductions for dividends. In other words the profits of business have not trickled down, but have flowed down in a veritable torrent to the benefit of the economy by the creation of new jobs and the creation of new productive facilities which have made more products available to the people as a whole. In the recent price rise in our economy, the prices of industrial products rose substantially less than the prices of products of the farm or than the increased wage costs for the nation as a whole.

And so I say, go out and talk to the men in the street, to the women in the homes, to the worker in the factory, to the driller in the fields, the roustabouts, and anyone that you can make listen. Tell them the true facts so that we may preserve for them the greatest real social experiment the world has ever seen—the American free enterprise system.

Oil Refineries for Britain

JOHN KINGSLEY, London

IN FOUR different parts of Britain, work is going ahead on one of the United Kingdom's most ambitious recovery projects—an eight-fold increase in her oil refining capacity. At Shellhaven, on the north bank of the Thames near London, at Stanlow on the Manchester Ship Canal, at Llandarcy near Swansea in South Wales, and at Grangemouth on the Firth of Forth in Scotland, refineries and their complementary by-products plants are either being built or having additions made. In coming months work will be started on three more oil refining projects.

The capital cost of these seven plants will be some $500 million. When completed they should treat nearly 425,000 barrels of crude oil daily, compared with little more than 50,054 barrels daily in 1947. Work is being pushed ahead rapidly so that by next year the annual output should have reached 166,000 barrels of crude oil daily.

While growing demands for oil products partly account for this activity, the most important objectives are the saving of dollars and a practical contribution to European recovery, British officialdom explains. By expanding her refining capacity at home and overseas, Britain will eventually save on imports. It is cheaper, too, to buy crude oil and refine it than to buy finished petroleum products. Purchases from the United States will be cut down. At the same time, British oil companies will be able to play an increasing part in supplying sterling-area countries, Western Europe, and other parts of the world with petroleum products which can be paid for in sterling and not dollars. As her refining capacity expands, Britain will also be able to increase her production of petroleum by-products, many of which are now imported from the dollar area.

Another important reason is that it is part of the development of Britain's and Western Europe's basic industries, on which successful production of so many finished goods depends and in which oil is taking an increasingly vital place with coal, steel, chemicals and cement. Oil refining is in fact developing into one of Western Europe's major industries.

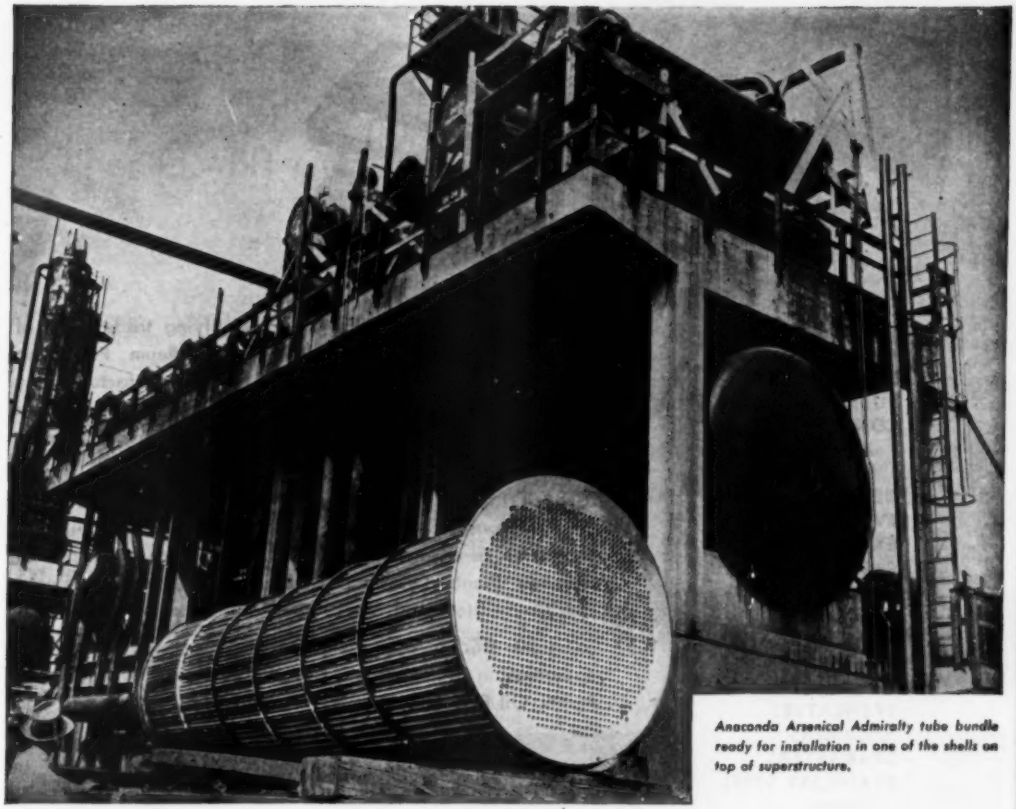
Britain's oil expansion program is not limited to multiplying her home refining capacity, because concerns are also interested in Middle East oilfields, which are radiply increasing production. British companies are producing in Latin America, the West Indies and India, as well. Including the Royal Dutch-Shell group, a partnership of British and Dutch undertakings, oil production of British concerns rose from about 955,000 barrels daily in 1946 to 1,125,000 barrels daily in 1947, and was probably about 1,333,000 barrels daily last year. By 1953 it may double the 1947 total.

Overseas Refining Capacity

Plans for increasing overseas resources include a new refinery in Venezuela and the enlargement of existing refineries in the Middle East and East Indies. By 1953 it is hoped to increase refining capacity overseas by 40 percent. Increasing output from the Middle East will entail additions to existing pipe lines and the laying of new ones.

Expanding world demand for oil has meant a call for more tanker ships. From 242,000 at the end of 1946, the tonnage of tankers being built in British yards rose to 414,000 at the end of 1947 and to 608,000 at December 31, 1948. The latter was nearly one-half of all the tanker tonnage being built throughout the world.

The savings in dollars which these projects will bring eventually must not overshadow the immediate cost to Britain. Until adequate supplies come from non-dollar areas, she must continue to import a lot of "dollar" oil, while at the same time financing large expenditure on steel and other materials for the expansion program, much of which has to be in dollar and other scarce currency. Also, as she is now supplying Western Europe with about 40 percent of its oil, Britain is in effect not only contributing to European recovery but is doing so only at cost of substantial drain on her gold and dollar resources, British officials point out.



Anaconda Arsenical Admiralty tube bundle ready for installation in one of the shells on top of superstructure.

Light Hydrocarbon from Fractionating Towers

Handled by ANACONDA ARSENICAL ADMIRALTY TUBES . . .

THE CONDENSERS shown in the photographs above are located at the butadiene plant of Sinclair Rubber, Inc., Houston, Texas. They were built to handle light hydrocarbon from the fractionating towers.

In order to provide the required heat transfer and economical service under the corrosive conditions encountered, the tubes being installed are Anaconda Arsenical Admiralty 439.

This Anaconda Alloy has been manufactured on a commercial basis since 1934. It is but one of 8 standard and several special condenser tube alloys currently produced by The American Brass Company.

This list provides tubes to meet a wide range of heat transfer requirements. The broad metallurgical knowledge and practical experience of our Technical Department is available in helping you make the right selection. 60130

ANACONDA

Anaconda

CONDENSER TUBES

THE AMERICAN BRASS COMPANY

General Offices: Waterbury 88, Connecticut

Subsidiary of Anaconda Copper Mining Company

In Canada: ANACONDA AMERICAN BRASS LTD., *New Toronto, Ont.*

ABSORBERS
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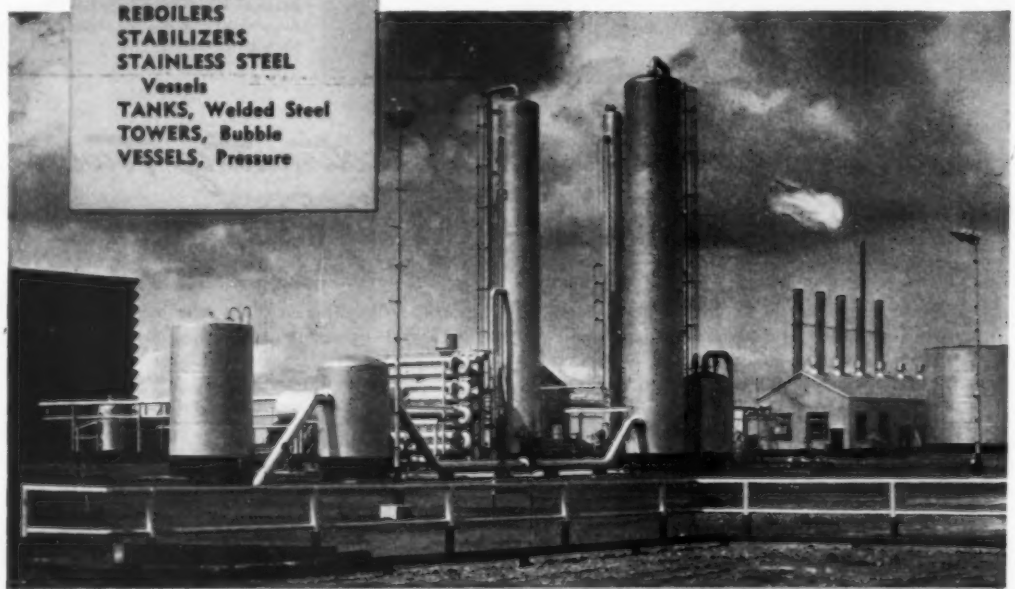
EVAPORATORS
EXTRACTORS-Mist
FABRICATED STEEL
FRACTIONATING COLUMNS
HEAT EXCHANGERS
HEATERS
Storage Tank
PREHEATERS
REBOILERS
STABILIZERS
STAINLESS STEEL Vessels
TANKS, Welded Steel
TOWERS, Bubble
VESSELS, Pressure

TULSA TYPE—is the identifying trade mark of the complete line of Petroleum Processing Equipment designed and manufactured by Flint Steel Corporation. All TULSA TYPE Units include modern features of design for efficiency of operation.

TULSA TYPE equipment complies with industry codes such as API-ASME and ASME. During the past years this organization has served as a convenient and reliable source of supply for Gasoline Plants—Oil Refinery Equipment—Structural Steel—Warehouse Steel and Steel Plate Fabrication.

To insure efficient operation, specify TULSA TYPE processing equipment in Cycling Plants, Natural Gasoline Plants, Chemical Plants, Oil Refineries and Gas Transmission Systems.



FLINT STEEL CORPORATION

TULSA, OKLAHOMA, U.S.A.

Export Office: Room 1940, 30 Rockefeller Plaza, New York 20, N. Y.

REFINERY and Other PLANT CONSTRUCTION

Petroleum Refiner's *exclusive feature which, in boxscore form, presents a quick picture of the tremendous amount of plant construction work that is in progress or projected by oil and other companies in all sections of the world.*

The tabulation presented each month under the heading "Refinery and Other Plant Construction" represents a continuing check of the building program that is in progress in the refining, natural gasoline and petrochemical industry. Since August, 1947, it has appeared as an exclusive feature in PETROLEUM REFINER and it has proved a valuable aid and guide to our readers.

Companies whose projects are not listed or readers who know of projects not listed are urged to: 1) send in data on such units as called for by column headings; 2) furnish details which are missing in any item in the current tabulation, and 3) report from time to time on the progress of these projects. Address, Editor, PETROLEUM REFINER, Box 2608, Houston 1, Texas. Cooperation together with suggestions are very much appreciated.

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
EAST									
Esso Standard Oil	Linden, N.J.	Vac. pipe still	49,000 bbls.	.....	Under Constr.	1st Qtr., 1949	.....	S.O.D. & Braun	Braun
Esso Standard Oil	Linden, N.J.	Cat. Crack, Light Ends	41,000 bbls.	.....	Under Constr.	2nd Qtr., 1949	.....	S.O.D., Braun	Braun
Esso Standard Oil	Bayonne, N.J.	Dewaxing	7,500 bbls.	.....	Under Constr.	1st Qtr., 1950	Texaco	Badger	Badger
Esso Standard Oil Co.	Linden, N.J.	Steam Boiler	260,000 lbs. hr.	.....	Under Constr.	1st Qtr., 1949	.....	S. O. D.	.....
Esso Standard Oil Co.	Bayonne, N.J.	Steam Boilers	400,000 lbs. hr.	.....	Under Constr.	2nd Qtr., 1950	.....	S. O. D., Day & Zimmermann	S. O. D., Day & Zimmermann
*Freeport Sulphur Co.	Westville, N.J.	Sulfur Recovery Plant	40 tons	.....	Contracted	.....	.....	.....	Girdler
Gulf Oil Corp.	Philadelphia, Pa.	Topping and Vacuum Unit	30,000 bbls.	.....	Under Constr.	Nov., 1949	.....	Lummus, Badger	Lummus
Socony-Vacuum Oil Co., Inc.	Paulsboro, N.J.	Crude, Dist. Unit	19,500 bbls.	.....	Under Constr.	Mid 1949	.....	Badger	Badger
Socony-Vacuum	Paulsboro, N.J.	Propane Deasphalting	5,950 bbls.	.....	Under Constr.	Mid 1949	Juik	Badger	Badger
Socony-Vacuum	Paulsboro, N.J.	Furfural Refg.	4,450 bbls.	.....	Under Constr.	Mid 1949	Texaco	Badger	Badger
Socony-Vacuum	Paulsboro, N.J.	MEK Dewaxing	2,050 bbls.	.....	Under Constr.	Mid 1949	Texaco	Badger	Badger
Socony-Vacuum	Paulsboro, N.J.	Clay Contact Unit	3,000 bbls.	.....	Designing	Late 1949	.....	Badger	Badger
Socony-Vacuum Oil Co., Inc.	Paulsboro, N.J.	Light Oil Treating Plant	28,000 bbls.	.....	Designing	Mid 1949	.....	Badger	Badger
L. Sonneborn Sons, Inc.	Petrolia, Pa.	Enlarge Anti-Pollution	.....	$400,000	Under Constr.	Middle 1949	.....	Chemical Constr. Co.	Morris Knowles & Co.
Sun Oil Co.	Marcus Hook, Pa.	Wax	.....	.....	Under Constr.	July, 1949	Texaco	Staff	Staff
Sun Oil Co.	Marcus Hook	Comp. & Pkg.	.....	.....	Under Constr.	August, 1949	.....	Staff—Lindsay	W. W. Lindsay
The Texas Co.	Beacon, N.Y.	Expand Research Labs.	.....	.....	Under Constr.	Jan., 1950	.....	Voorhees, Walker, Foley & Smith	.....
The Texas Co.	Westville, N.J.	New Refinery	40,000 bbls.	.....	Under Constr.	July, 1949	.....	Foster-Wheeler, Jackson-Moreland, Kellogg	Foster-Wheeler, Kellogg
*Tide Water Associated Oil Co.	Bayonne, N.J.	Furfural Refining Unit	.....	.....	Under Constr.	June, 1949	Texaco	Pritchard	Pritchard
U.S. Dept. of Interior	Bruceton, Pa.	Fischer-Tropsch Pilot Plant (Coal-to-gasoline synthesis)	1-3 bbls.	$150,000	Under Constr.	June, 1949	.....	Staff	Blaw-Knox Co.
MID-CONTINENT									
Ashland Oil & Refining Co.	Canton, Ohio	Ref. Modernization	.....	.....	Under Constr.	Middle 1949	.....	.....	Cat. Constr.
The Carter Oil Co.	McKamie, Ark.	Pressure Maintenance Unit	38,000 mcf	.....	Under Constr.	July, 1949	.....	J. & L. Constr.	J. & L. Cons
*Champlin Refining Co.	Enid, Oklahoma	Crude Unit	18,000 bbls.	$600,000	Under Constr.	Fall, 1949	.....	Koch	Staff
*Champlin Refining Co.	Enid, Oklahoma	Cat Poly Unit	450 bbls.	$200,000	Under Constr.	Fall, 1949	U.O.P.	Koch	Staff
Cities Service Oil Co.	Chicago	Compounding & Grease Plant	1,200 bbls.	$2.5 million	Design	Late 1949	.....	Sumner-Sollitt	.....
Cooperative Refinery Association	Coffeyville, Kansas	Dewaxing	2,200 bbls.	$1.5 million	Contracted	3rd Quarter, 1949	Texaco	Process Eng.	Process Eng.
Cooperative Refinery Assoc.	Coffeyville, Kansas	Modernize Gasoline Plant	20,000 bbls.	$900,000	Under Constr.	June, 1949	U.O.P.	U.O.P., Staff	Staff
Continental Oil Co.	Ponca City Oklahoma	Crude Dist. Unit	30,000 bbls.	.....	Under Constr.	Oct., 1949	.....	Bechtel	Bechtel
Devoe Oil Co.	Weston, Ohio	Lube Filtering Unit, Dewaxing	250 bbls.	$15,000	Under Constr.	Spring, 1949	.....	Staff	Staff
The Globe Oil & Refining Co.	Lemont, Ill.	Cat. Cracker Unit	6,000 bbls.	$1 million	Buying Material	Jan. 1, 1950	U.O.P.	U.O.P.	.....
Gulf Oil Corp.	Kiefer, Okla.	Expand Gasoline Plant	14,500 mcf	.....	Under Constr.	.....	.....	.....	.....
Gulf Refg. Co.	Toledo, Ohio	Fluid Cat. Crk.	15,500 bbls.	.....	Under Constr.	Sept., 1949	.....	Kellogg	Kellogg
Gulf Refg. Co.	Toledo, Ohio	Poly Unit	5,000 bbls.	.....	Under Constr.	Aug., 1949	U.O.P.	Kellogg	Kellogg
Gulf Refg. Co.	Cincinnati, Ohio	Fluid Cat Cracker Unit	15,500 bbls.	.....	Under Constr.	Oct., 1949	.....	Kellogg	Kellogg
Gulf Refg. Co.	Cincinnati, Ohio	Poly Unit	5,000 bbls.	.....	Under Constr.	Sept., 1949	U.O.P.	Kellogg	Kellogg
Lion Oil Co.	El Dorado, Ark.	Enlarge Ammonia Unit	570 tons	$3.5 million	Under Constr.	June, 1949	.....	Chem. Constr.	Chem. Constr.

* CONTINUED ON NEXT PAGE

REFINERY AND OTHER PLANT CONSTRUCTION (Continued)

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Lion Oil Co.	El Dorado, Ark.	Sulfuric Acid Plant	300 tons	$1¼ million	Under Constr.	Sept., 1949		Chem. Constr.	Chem. Constr.
Lion Oil Co.	El Dorado, Ark.	Ammonium Sulfate Plant	380 tons	$750,000	Under Constr.	Sept., 1949		Chem. Constr.	Chem. Constr., Blaw-Knox
M. F. A. Oil Co.	Chanute, Kans.	Desulfurization	1,000 bbls.	$75,000	Under Constr.	June, 1949	Phillips	Koch	Staff
Magnolia Pet. Co.	Grant County, Kans.(Hiekok)	Gasoline Plant	100,000 mcf		Buying Material	Nov., 1949		Staff	Walco
Magnolia Pet. Co.	Grady County, Oklahoma	Gasoline Plant	25,000 mcf		Design	Jan., 1950		Staff	
Magnolia Petroleum Co.	Stephens County, Okla.	Gasoline Plant	30,000 mcf		Under Constr.	Jan., 1950		Staff	J & L. Constr.
Mercury Oil Refining Co.	Oklahoma City, Oklahoma	Crude Unit	5,000 bbls.	$300,000		Completed		Ref. Eng.	Ref. Eng.
Midland Cooperative Wholesale	Cushing, Okla.	Cat. Poly Unit	200 bbls.		Authorized	Middle, 1949			Ref. Eng., U.O.P.
Ohio Oil Co.	Robinson, Ill.	Vac. Unit Cat. Crack, Crude Still, Poly, LP G Recovery	27,500 bbls.	$15 million	Under Constr.	Early, 1949	U.O.P.	McKee	McKee, Pritchard
Peteo Corp.	Blue Island, Ill.	Houdriflow Cat. Cracker Unit, LPG Recovery System	5,000 bbls.	$400,000	Under Constr.	Last Quarter, 1949	Houdry	Houdry	Clark's
Phillips Pet. Co.	Kansas Cy, Kans.	Cat. Crack	24,000 bbls.		Under Constr.	Oct., 1949		Braun	Braun
Phillips Pet. Co.	Kansas Cy, Kans.	Cat. Poly	1,500 bbls.		Under Constr.	Oct., 1949		Braun	Braun
Phillips Pet. Co.	Guymon, Okla.	Absorption Plant	173,000 mcf		Under Constr.	July, 1949			
The Pure Oil Co.	Toledo, Ohio	Revamping Crude Reforming Units			Under Constr.	1st Qtr., 1949			Cat. Constr
R. J. Oil & Refining Co., Inc.	Princeton, Ind.	Electric Desalter	1500 bbls.	$15,000	Under Constr.		Petro	State Eng.	State Eng.
Rock Island Refg. Corp.	Rock Island, Ind.	Fluid Cat. Crk.	10,000 bbls.	$1,200,000	Contracted	July, 1949	U.O.P.	U.O.P.	Staff
The Shallow Water Refining Co.	Shallow Water, Kansas	Reforming Unit	1,250 bbls.	$85,000	Under Constr.	Fall, 1949	Perco	Koch Eng.	Koch Eng.
Skelly Oil Co.	Eldorado, Kans.	Crude Dist. Unit, Cat. Crk.	35,000 bbls.		Under Constr.	Mid 1950			
Socony-Vacuum	E. St. Louis, Ill.	Crude Distillation	15,000 bbls.		Under Constr.	Aug., 1949		Bechtel, Staff	Bechtel
Socony-Vacuum Oil Co.	East St. Louis, Illinois	Thermal Cracking, Reforming, Visbreaker Unit	13,200 bbls.		Under Constr.	Dec., 1949		Staff, Bechtel	Bechtel
Socony-Vacuum Oil Co.	East St. Louis, Illinois	Tannin Solutizer Treating Unit	18,000 bbls.		Under Constr.	June, 1949		Staff, Bechtel	Bechtel
Socony-Vacuum Oil Co.	East St. Louis, Illinois	Misel. Refinery Additions			Under Constr.	Sept., 1949		Staff, Bechtel	Bechtel
Socony-Vacuum Oil Co.	East St. Louis, Illinois	Delayed Coking Unit	8,000 bbls.		Under Constr.	Oct., 1949		Staff, Bechtel	Bechtel
Standard Oil Co., (Ohio)	Lima, Ohio	Furfural Refining Plant	76,000 gals.	$13 million	Contracted	1951	Texaco	Lummus	Lummus
Standard Oil Co., (Ohio)	Lima, Ohio	Cat. Cracking	16,000 bbls.	$11 million	Under Constr.	Late 1949	U.O.P.	McKee	McKee
Standard Oil Co., (Ohio)	Lima, Ohio	Crude Distl., Coke	115,000 bbls.	$5 million	Authorized	Mid 1950	Kellogg	Kellogg	Kellogg
Standard Oil Co., (Ohio)	Lima, Ohio	Solvent Dewaxing Unit	1,800 bbls. Finished Products		Authorized	Mid 1950	Texaco	Lummus	Lummus
Standard Oil Co., (Ohio)	Lima, Ohio	Vacuum Unit	9,000 bbls.		Authorized	Mid 1950			Lummus
Standard Oil Co., (Ohio)	Lima, Ohio	Propane Deasphalting Unit	800 bbls.		Authorized	Mid 1950			Lummus
Sun Oil Co.	Toledo, Ohio	Cat. Crack, Crude Dist., Vac., Poly	30,000 bbls.	$16 million	Under Constr.	Jan., 1950	Houdry	Houdry, Cat. Constr., Process Eng., Staff	Cat. Constr.
Sun Oil Co.	Toledo, Ohio	Anti-Pollution	600,000		Under Constr.	June, 1949		Sun Oil	Cat. Constr.
The Texas Co.	W. Tulsa, Okla.	Expand. Modernize Refinery	30,000 bbls.		Under Constr.	July 1, 1949		Kellogg, Foster-Wheeler, U.O.P.	Kellogg, Foster-Wheeler
The Texas Co.	Lawrenceville, Illinois	Expand Refinery	120,000 bbls.		Design	Jan. 1, 1952		Foster-Wheeler, Kellogg	Foster-Wheeler, Kellogg
Tide Water Associated Oil Co.	Drumwright, Oklahoma	Houdriflow Unit Cat. Cracker	4,500 bbls.		Contracted		Houdry		Process Eng.
U.S. Dept. of Interior	Louisiana, Mo.	Demonstration Oil-from-Coal Plant	75 bbls.	$4.4 million	Under Constr.	Oct., 1949		Koppers	Koppers
West Cement Medrano Unit	Caddo County, Oklahoma	Gas Injection Facility	9000 mcf	$1 million	Under Constr.	June, 1949		Dresser	Dresser
Wood River Oil & Refining Co., Inc.	Hartford, Ill.	Vacuum Unit	15,000 bbls.	$700,000	Under Constr.	June, 1949		Koch	Staff
Wood River Oil & Refining Co., Inc.	Hartford, Ill.	Fluid Cat. Cracker	7500 bbls.	$2.5 million	Under Constr.	Dec., 1949	U.O.P.	Koch	Staff
SOUTHWEST									
The Atlantic Refining Co.	Block 31, Crane County, Texas	Gas Injection Plant	8,320 mcf		Under Constr.	June, 1949		Hudson, Staff	Hudson
The California Co.	Brookhaven, Mississippi	Cycling Plant	10,000 mcf		Designing	3rd Qtr., 1949		Hudson	Hudson
Barnsdall Oil Co.	Placedo, Tex.	Compressor Station	2000 hp.	$380,000	Under Constr.	June, 1949		Olsen	Olsen
Brazos Oil & Gas. Co.	Magnet, Texas	Compressor Station	600 h.p.	$175 000		Completed		Staff	Delta
Calumet Ref. Co.	Princeton, La.	Blending Oil Tank House	700 bbls.		Under Constr.	3rd Qtr., 1949		Staff	Staff
Carthage Corp.	Carthage Field	Gasoline Plant	250,000 mcf	$3.5 million		Completed		Hudson	Hudson
Carthage Hydrocol, Inc.	Brownsville, Texas	Hydrocol	87,000 mcf	$26 million	Under Constr.	Dec., 1949	Hydro-Res., Inc. Texaco	McKee, Hydro-Res., Inc.	McKee
The Chicago Corp.	Carthage, Texas	Enlarge Gas Plt	210,000 mcf	$2 million	Under Constr.	June, 1949		Fish Eng.	Fish Eng.
Cit-Con Corp.	Lake Charles, La.	Lube Plant	6,000 bbls.	$35 million	Under Constr.	Oct., 1949	Texaco, Max B. Miller	Max B. Miller, Lummus	Lummus, Max B. Miller
Cities Service Oil Co.	Pampa, Texas	Gasoline Plant	18,000 mcf		Contracted	1949		Walco	Walco
Cities Service Oil Co.	Chico Field, Wise Co., Tex.	Natural Gasoline Plant	22,000 mcf		Planned	Early, 1950			
Claiborne Gasoline Co.	Lisbon, La.	Enlarge Pipeline Absorption Plant	125,000 mcf		Under Constr.	June, 1949		Pet. Eng.	
Continental Oil Co.	Todd (Deep) Field, Texas	Gas Recovery Plant	10,000 mcf		Under Constr.	Sept., 1949		Ref. Maint.	Ref. Maint.
Conden Pet. Corp.	Big Spring, Tex.	Fluid Cat. Plant	6,000 bbls.	$2 million	Under Constr.	Nov., 1949	U.O.P.	U.O.P.	Ref. Eng
Department of the Army	Houston, Tex.	Anhydrous Ammonia Facility	2100 tons monthly	$2.5 million	Relocating	Sept., 1949		Girdler Corp.	Hercules Powder Co.
E. I. duPont de Nemours Co., Inc.	Victoria Tex.	Chemical Intermediates for Nylon			Design	Early 1951		Staff	Staff

■ CONTINUED ON PAGE 100

AEROCAT CATALYSTS...

provide high octane fuel for modern engines

Modern fluid cracking techniques are accomplishing refining operations today that only a few years ago would have been considered impossible. Cyanamid has contributed to this progress by the development of the remarkably efficient AEROCAT* Ground and Microspheroidal Synthetic Fluid Catalysts, now in expanded full scale production at Cyanamid's modern Fort Worth plant.

The experience, the skill, the extensive research and technical facilities that made these new products possible are at your service in the selection and use of the right catalyst to meet your specific requirements.

Other Cyanamid chemicals for the petroleum industry include AEROLUBE* Additives for regular, premium and heavy-duty motor oils . . . AERO** Specialty Catalysts for various chemical processes, Gasoline Dyes and Drilling Mud Chemicals. Literature and samples of these products are available upon request. Write today.

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WHEN PERFORMANCE COUNTS . . . CALL ON CYANAMID

REFINERY AND OTHER PLANT CONSTRUCTION (Continued)

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Esso Standard Oil Co.	Baton Rouge, La.	Light Ends Recovery	20,000 mcf	.....	Under Constr.	1st Qtr., 1949	.....	S.O.D., McKee	McKee
Esso Standard Oil Co.	Baton Rouge, La.	Light Ends	11,000 bbls.	.....	Under Constr.	1st Qtr., 1949	.....	Braun	Braun
Ethyl Corp.	Baton Rouge, La.	Mfg. Facilities	.....	$40 million	Under Constr.	Oct., 1949	.....	Stone & Webster	Stone & Webster
Gray-Wolfe Co.	Montgomery Co.	Gasoline Plant	13,000 mcf	$2 million	.....	Completed	.....	O. L. Olsen	O. L. Olsen
Gulf Oil Corp.	Crane, Texas	Gasoline Plant	40,000 mcf	.....	Under Constr.	July, 1949	.....	Braun	Braun, W. D. Bowden
Humble O&R Co.	Katy, Texas	Add Propane, Absorption, refrigeration	Unchanged	$7 million	Under Constr.	Oct., 1949	.....	Stearns-Roger	Stearns-Roger
Humble O&R Co.	Kelsey Field, Texas	Gas Injection Plant	18,000 mcf	$1,408,000	Under Constr.	June, 1949	.....	Stearns-Roger	Stearns-Roger
Humble O&R Co.	Conroe, Texas	Add Absorption	30,000 mcf	$4,160,000	Under Constr.	Summer, 1949	.....	Stearns-Roger	Stearns-Roger
Humbe O&R Co.	Heyser Field Texas	Gas Comp. Plant	23,000 mcf	.....	Under Constr.	April, 1949	.....	Belleo Ind. Piping Co.	Belleo Ind. Piping Co.
Humble O&R Co.	Opelousas, La.	Absorption Plant	110,000 mcf	$2,800,000	Under Constr.	Summer, 1949	.....	Hudson	Hudson
Humble O&R Co.	Pickton Field, Texas	Absorption Plant	18,000 mcf	$2,125,000	Under Constr.	June, 1949	.....	Fluor	Fluor
Humble O&R Co.	Baytown, Texas	Pipe Stills	45,000 bbls.	$5.8 million	Under Constr.	Late 1949	.....	Foster-Wheeler	Foster-Wheeler
Humble O&R Co.	Baytown, Texas	Lube Extraction	7,000 bbls.	$5.3 million	Under Constr.	Late 1949	.....	Kellogg	Kellogg
Humble O&R Co.	Flour Bluff Field, Texas	Compression Plant	12,000 mcf	.....	Under Constr.	June, 1949	.....	Tellepsen	Tellepsen
Humble O&R Co.	Imogene-Jourdanton-Charlotte Fields, Texas	Compression Absorption Plt.	26,000 mcf	.....	Contracted	1949-1950	.....	.....	Hudson
Humble O&R Co.	Thompsons, N. Thompsons, S. Thompsons Field, Texas	Gas Compression Plant	18,500 mcf	.....	Under Constr.	June, 1949	.....	Brown Eng.	Brown Eng.
Hutex Oil & Refining Co.	Hardin, Tex.	Fractionators for Solvents	1,000 bbls.	$50,000	Buying Materials	July, 1949	.....	Staff	Staff
Jefferson Chem. Co.	Austin, Texas	Central Research Facilities	.....	.....	Under Constr.	Sept., 1949	.....	Staff	Staff
La Gloria Corp.	Falfurrias, Tex.	Casinghead Gas	40,000 mcf	.....	.....	Completed	.....	Hudson	Hudson
Lone Star Gas	Dallas, Texas	Hypersorption Plant	60 mcf	.....	Design & Eng.	1949	Union Oil Co.	Foster-Wheeler	Foster-Wheeler
Magnolia Pet. Co.	Seeligson Field, Texas	Gasoline and Cycling	†70,000 mcf (Casinghead †150,000 mcf (Cycled	.....	Under Constr.	Sept., 1949	.....	Hudson	Hudson
Midland Gasoline Co.	Conroe Field, Texas	Enlarge Gasoline Plant	100,000 gals.	.....	Under Constr.	Dec., 1949	.....	Gaso. Plant	Gaso. Plant
Monsanto Chemical Co.	Columbia, Tenn.	Smoke Washing Unit	.....	$750,000	Under Constr.	June, 1949	.....	Staff	Rust Eng.
Nueces Corp.	Agua Dulce Field, Texas	Gas Compression	.....	.....	.....	Completed	.....	.....	.....
Odessa Natural Gasoline Co.	Odessa, Texas	Enlarge Gasoline Plant	65,000 gals.	$1 million	.....	Completed	.....	J. & L. Constr.	J. & L. Constr.
Pan American Refining Corp.	Texas City, Texas	Expand Chemical Research Facilities	.....	.....	Contracted	Jan., 1950	.....	Staff, H. K. Ferguson	Staff, H. K. Ferguson
Pan American Refining Corp.	Texas City, Tex.	Revamping Crude Unit	.....	.....	Engineering	Late 1949	.....	Tellepsen	Tellepsen
Panhandle Producing & Refg. Co.	Wichita Falls, Texas	Cat. Cracker	1,500 bbls.	$1 million	Engineering	March, 1950	U.O.P.	U.O.P., J. & L. Constr.	J. & L. Constr.
The Parade Co.	Rusk County, Texas	Add Propane Recovery	18,000 mcf	$250,000	.....	Completed	.....	Hudson	Hudson
Petrol Refining, Inc.	Texas City, Texas	Crude Topping Units	50,000 bbls.	.....	Under Constr.	June, 1949	.....	Rust. Eng.	Rust. Eng.
Phillips Chemical Co.	Elter, Tex.	Anhydrous Ammonia	†70,000 tons year	$5.3 million	Under Constr.	July, 1949	Chem Constr.	Chem. Constr.	Brown & Root
Plymouth Oil Co.	Rankin, Texas	Gas Compression, Absorp.	70,000 mcf	$3½ million	Under Constr.	1949-50	.....	.....	Hudson
The Pure Oil Co.	Nederland, Tex.	Wax Fractionation	200 bbls.	.....	Under Constr.	Sept., 1949	Texaco	Lummus	Lummus
Shamrock Oil & Gas Co.	Sunray, Texas	Increase Topping & Cracking Facilities	10,000 bbls.	$300,000	Under Constr.	3rd Qtr., 1949	U.O.P.	Staff	Staff
Shamrock Oil & Gas Co.	Sunray, Tex.	Gas-Compressor Unit	2900 hp.	$500,000	Under Constr.	July, 1949	.....	Staff	Staff
Shell Chem. Co.	Houston, Texas	Extend Acetone Facilities	.....	.....	Under Constr.	Late 1949	.....	Braun	Braun
Shell Oil Co.	Provident City, Tex.	Gas Stripping	60,000 mcf	.....	Projected	1st qtr., 1950	.....	Staff	.....
Shell Oil Co.	Notrees, Texas	Extension TXL Plant	30,000 mcf	.....	Under Constr.	Early 1950	.....	Brown & Root	Brown & Root
Shell Oil Co.	Denver City, Texas	Gas Compression, Absorp. Addition	30,000 mcf	.....	Under Constr.	Late 1949	.....	Fluor	Fluor
Sinclair Prairie Oil Co.	Midway Lane Field, Texas	Gas Compression	.....	.....	Under Constr.	Early, 1949	.....	.....	.....
Skelly Oil Co.	Skellytown, Tex.	Expand Gasoline Plant	.....	.....	Under Constr.	Fall, 1949	.....	.....	J. E. Carlson
Southern Minerals Corp.	Stratton Field, Texas	Gas Compression Addition	.....	.....	Under Constr.	1st Qtr., 1949	.....	.....	.....
Stanolind O&G Co., Opr	Fullerton Field, Texas	Gasoline Plant	55,000 mcf	.....	Under Constr.	Jan., 1950	.....	J. & L. Constr.	J. & L. Constr
Stanolind O&G Co.	Brownsville, Tex.	Chemical Plant	130,000 lbs./yr.	.....	Under Constr.	Jan. 1, 1950	.....	Badger	Badger
Stanolind O&G Co.	Pettus, Texas	Cycling Plant	166,000 mcf	.....	Completed	.....	.....	J. & L. Constr.	J. & L. Constr
Stanolind O&G Co.	Levelland Field, Texas	Gasoline Plant	.....	.....	Under Constr.	1950	.....	Brown & Root	Brown & Root
Stanolind O&G Co.	N. Cowden, Tex.	Gasoline Plant	75,000 mcf	.....	Engineering	1950	.....	Stearns-Roger	Stearns-Roger
Sun Oil Co.	Starr Co., Texas	Gasoline Plant	35,000 mcf	$4 million	Under Constr.	June, 1949	Pet. Eng.	Pet. Eng.	Pet. Eng.
Sun Oil Co.	Jameson Field, Coke County Texas	Gasoline Plant	10,000 mcf	Part of $12 million	Under Constr.	June, 1949	.....	Pritchard	Pritchard
Tex. Natl. Gas Corp. & Sick-Ursche l Oil Co.	Rankin, Tex.	Gasoline Plant	55,000 mcf	.....	Under Constr.	Late 1949	.....	Tex. Natl. Gas Corp.	Tex. Natl. Gas Corp.
The Texas Co.	Port Arthur, Texas	Lube & Wax Additions	†37,500 Crude †2,500 bbls. Oil	.....	Under Constr.	June, 1949	.....	Foster-Wheeler	Foster-Wheeler
The Texas Co.	Port Arthur, Texas	Change to Linde Solutiser Treating Facilities	.....	.....	.....	Completed	.....	Foster-Wheeler	Foster-Wheeler
The Texas Co.	Ganado Field, Texas	Gas Compression	5,000 mcf	.....	.....	Completed	.....	.....	.....
The Texas Co.	Tijerina-Canales Field, Texas	Gas Compression	6000 mcf	.....	Under Constr.	Oct., 1949	.....	.....	.....
The Texas Co.	Chalk-Hill Field, Texas	Gas Compression, Absorp.	2000 mcf	.....	Under Constr.	August, 1949	.....	.....	.....

■ CONTINUED ON PAGE 103

COPPER ALLOY BULLETIN

MARINE AND POWER EDITION

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared by Bridgeport Brass Company "Bridgeport" *Headquarters for BRASS, BRONZE, and COPPER*

Duplex Tubing for Lower Maintenance in Ammonia Refrigeration Systems

The rapid growth and penetration of mechanical refrigeration into industrial, commercial and domestic fields has introduced new corrosion and maintenance problems to operating engineers.

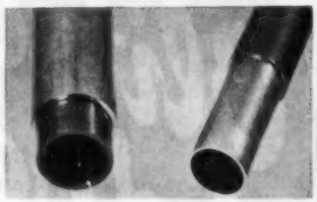
The selection of piping and tubing used in refrigeration and air conditioning requires careful consideration. In Freon refrigeration systems, copper tubing with brazed fittings gives satisfactory service since the copper resists corrosion from both Freon and water. Copper, however, is not satisfactory for direct contact with ammonia since it is attacked by the refrigerant.

The good corrosion resistance of steels to ammonia, both gaseous and liquid, explains the wide use of ferrous materials in the construction of equipment handling ammonia. However, steel tubes and pipes are subject to corrosion when immersed in brine, sea water or fresh water. This shortcoming can easily be overcome through the use of Duplex Tubing, consisting of non-rusting copper or copper-base alloy to the water side and steel to the ammonia side. This combination of Duplex Tubing is finding wide application not only for ammonia refrigeration, but, also, for equipment producing ammonia and its compounds.

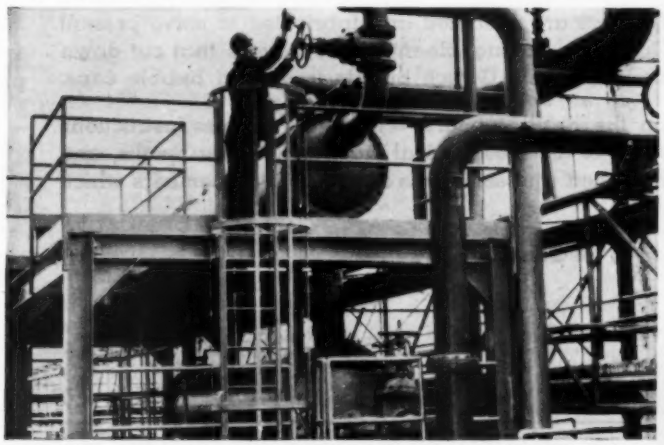
The most popular combinations are low carbon steel combined with Copper, Admiralty or Red Brass for handling fresh water from rivers, lakes, ponds, and wells. Where sea water is used for cooling purposes, 80-20 Cupro Nickel, 70-30 Cupro Nickel, Duronze* IV (Arsenical Aluminum Bronze), Aluminum Brass, and Admiralty are preferred to copper because of their greater corrosion resistance to sea water. When the velocity of the sea water is comparatively high, Cupro Nickel, Duronze IV and Aluminum Brass are preferred because of their resistance to impingement corrosion.

Satisfactory Heat Transfer

Duplex Tubing is made by drawing together two tubes, one within the other. The close mechanical bond obtained in this manner results in very satisfactory heat transfer characteristics. Duplex composed of steel and copper has somewhat higher heat transfer properties than single walled steel tubing of the same size and wall thickness. The practical significance of this is that the designer can use the lower fouling factor for copper or copper-base alloys rather than the higher value customarily used for steel which rapidly develops an insulating coat of rust. This means that Duplex Tubes in smaller sized heat exchangers can sometimes replace larger units equipped with single-walled steel tubes. When units are retubed with Duplex Tubes of steel to copper or steel to copper-base alloys, greatly improved heat transfer properties may be anticipated, especially where excessive rusting (by water) is encountered on steel.



Duplex Tubing with outside tubes cut back to show construction.



Duplex Tubing of copper to the water side with steel to the ammonia side used in ammonia condensers. Courtesy Dow Chemical Company.

Duplex Tubing Reduces Maintenance and Replacement

Remarkable savings in maintenance and replacement have been reported by users of Duplex Tubing for ammonia refrigeration systems. A small dairy which installed copper lined steel Duplex Tubing 11 years ago reported that previous to the replacement, rust and scale had to be removed from the inside of the steel tubes every three months and the tubes themselves were replaced about every three years. Since the installation of Duplex Tubing, no cleaning has been necessary and the original Duplex Tubing is still giving excellent service.

Write for "Duplex Tubing Technical Bulletin No. 746" and contact nearest Bridgeport office. *U. S. Pat. No. 2,093,380

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Tray illustrated is 8'-10" in diameter to fit a 9'-0" diameter tower. Material is 10-gauge carbon steel with 12-gauge caps and risers. Tray is provided with internal manway, and removable caps and risers. All tray parts are designed to pass through a 16" tower manway. The tray incorporates the usual GLITSCH features of trusses, tray clamps, frictional washers and expansion joints. (In this installation corrosion was not a factor.)

Glitsch does it!

BUBBLE TRAYS TAILOR-MADE TO FIT YOUR TOWERS

Glitsch "Truss-Type" bubble trays are designed and fabricated to solve present day refining difficulties. Corrosion, coking, cleaning — problems that cut down "on-stream" time — are minimized with Glitsch bubble trays and bubble caps.

Every job is tailor-made on the drafting board — following process instructions of your engineers — fabricated of the most logical material for best results, and engineered with properly designed trusses, beams and structural members which insure easy installation.

No matter . . . it will pay you to let Glitsch do it.

Glitsch

MANUFACTURED UNDER U. S. PATENT NO. RE 22946; NO. 2,341,091; NO. 2,309,309; NO. 2,338,928; NO. 2,375,409; NO. 2,420,075; NO. 2,422,300; NO. 2,461,729 AND OTHER PATENTS PENDING

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"TRUSS-TYPE" BUBBLE TRAYS ● BUBBLE CAPS ● TOWER INTERNALS

REFINERY AND OTHER PLANT CONSTRUCTION (Continued)

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
The Texas Co.	Withers Field, Tex.	Expand Compression	9000 mcf		Under Constr.	July, 1949		Tellepsen	Tellepsen
United Gas Co.	Carthage, Texas	2nd Gas Plant	100,000 mcf	$3.5 million	Under Constr.	July, 1949		Hudson	Hudson
*United Gas Pipe Line Co.	Karnes City, Okla.	Natural Gas & Condensate Processing Plant	10,000 mcf	$1 million	Under Constr.	Jan., 1950		Delta	Delta
U.S. Ind. Chemicals Co.	Brownsville, Texas	Petrochemical Plant			Contracted	1949		Badger	Badger
*West Texas Gas Co.	Fritch, Texas	Enlarge Compressor Station	3150 Bhp		Projected	Aug., 1949		Staff	
ROCKY MOUNTAIN									
American Gilsonite Co. Co.	Bonanza, Utah	Gilsonite to Crude Oil Pilot Plant	300 tons	$300,000	Engineering	July, 1949		Staff	Staff
The Carter Oil Co.	Billings, Mont.	Crude Cat. Crk.	30,000 bbls.	$20 million	Under Constr.	3rd Qtr., 1949		U.O.P., S.O.D., Fluor	Fluor
Continental Oil Co.	Billings, Mont.	Complete Ref. Cat. Crack	7,500 bbls.	$1 million	Under Constr.	Oct., 1949	U.O.P.	U.O.P., J. & L. Constr.	J. & L. Constr.
Empire State Oil Co.	Thermopolis, Wyoming	Crude, Vacuum Units	5,000 bbls.	$325,000	Under Constr.	June, 1949		Ref. Eng.	Ref. Eng.
Gulf Oil Corp.	Eunice, N. M.	Gasoline Plant	50,000 mcf		Under Constr.	June, 1949		Hudson	Hudson
New Mexico Asphalt Refg. Co.	Artesia, N. M.	Crude Unit	7,500 bbls.	$350,000	Under Constr.	June, 1949		Geo. Armistead	Staff
The Pure Oil Co.	Worland, Wyo.	Gasoline Plant			Projected				
*Salt Lake Refining Co.	Salt Lake City, Utah	Capacity Increase	24,000 bbl.		Planned				
Skelly Oil Co.	Lea County, N. M.	Expanding Gasoline Plant	60,000 gals.		Under Constr.	Mid 1949			J. E. Carlson
Southern Union Gas Co.	Bloomfield, N. M.	Gasoline Plant	20,000 mcf	$1 million		Completed		Ref. Maint.	Ref. Maint.
Texas Gulf Sulphur Co.	Worland, Wyo.	Sulfur Recovery Plant	30,000 mcf		Projected				
*Union Oil Co. of Calif.	Cut Bank, Montana	Absorption Oil Heater and Superheater		$85,000		Completed		Parsons	
WEST COAST									
Barnsdall Oil Co.	Newhall, Calif.	Gasoline Recovery Unit	40,000 mcf		Under Constr.	June, 1949		Ref. Maint.	Ref. Maint.
General Petroleum Corp.	Torrance, Calif.	TCC Furnace Expansion	4,000 bbls.		Under Constr.	Early 1949		Staff-Lummus	Lummus
Hercules Powder Co.	Hercules, Calif.	Ammonia Plant			Under Constr.	Summer 1949		Staff	Bechtel
Shell Chem. Corp.	Dominguez, Cal.	Add Acetone			Under Constr.	July, 1949		Braun	Braun
Shell Oil Co.	Wilmington, Cal.	Extend Cracking Plant Cotrecsonv			Under Constr.	Middle 1949		Fluor	Fluor
Shell Oil Co.	Wilmington, Cal.	Extend Tank Storage			Under Constr.	Middle 1949		Staff	Chicago Bridge & Iron Co.
Stancal Asphalt & Bituminals Co.	Portland, Ore.	Asphalt Packing Plant, Warehouse			Under Constr.	June, 1949		Staff	
Standard Oil Co. of Calif.	Bakersfield, Calif.	Crude Dist.	10,000 bbls.	$7.5 million	Under Constr.	Mid 1949	Braun	Braun	Braun
Standard Oil Co. of Calif.	Bakersfield, Calif.	Thermal, Crk., Gasc. Stabil. Gasc. Treating	9,000 bbls.		Under Constr.	Late 1949	U.O.P.	U.O.P.	Braun
Standard Oil Co. of Calif.	El Segundo, Cal.	Cracked Naphtha Rerun Still	22,000 bbls.	$2.6 million	Contract let	Aug., 1949		Braun	Braun
*Sunset Oil Company	Los Angeles County, Calif.	Increase Topping Plant	†4000 bbls.	$150,000	Under Constr.	June, 1949		Staff	Process Constr.
Union Oil Co of California	Oleum, Calif.	Asphalt Refined Oil Loading Facilities		$457,000	Under Constr.	Late 1949		Early Constr.	Early Constr.
Union Oil Co. of California	Oleum, Calif.	Revision of Refining Facilities		$4 million	Under Constr.	Late 1949		Parsons, E. & A.	Ref. Maint.
Union Oil Co. of California	Oleum, Calif.	Revise Lube, Dewax Units	1,900 bbls.	$2.3 million		Completed	Union Oil Co.	Kellogg	Kellogg
Union Oil Co. of California	Oleum, Calif.	Improvements to Compound & Barrel Handling Facilities		$1.5 million	Under Constr.	Late 1949		Matthews Conveyor Co., J. M. Montgomery & Co.	Early, C. N., Peterson, Matthews Conveyor
Union Oil Co of California	Oleum, Calif.	Duo-Sol Unit	6,000 bbls.	$3 million	Under Constr.	3rd Quarter, 1949	Max Miller	Max Miller	Max Miller
Union Oil Co. of California	Oleum, Calif.	Tankage and Utilities		$1.8 million	Engineering	Late 1949		Parsons	Eaton & Smith
Union Oil Co. of California	Wilmington, Calif.	H_2S Recovery	30,000 lbs.	$356,000		Completed	No	Ehrhart & Arthur, Inc. Fluor	E. & A., Fluor
*Union Oil Co. of Calif.	Grimes Canyon, Calif.	Gas Injection Plant	3000 mcf	$112,000		Completed		Staff	Ind. Eng.
*Union Oil Co. of Calif.	Brea Olinda, Calif.	Enlarge Absorption Facilities	†6000 mcf		Engineering	4th Qtr., 1949		Parkhill-Wade	
FOREIGN									
Agwi Pet. Corp.	Fawley, Eng.		120,000 bbls.	$140 million	Projected	1952			
Anglo-Iranian Oil	Abadan, Iran	Gas Plant	25,000 mcf	$2 million	Under Constr.	1950		Badger	Badger
Anglo-Iranian Oil	Abadan, Iran	Cat. Cracker	30,000 bbls.		Under Constr.			Foster-Wheeler	Foster-Wheeler
Anglo-Iranina Oil	Abadan, Iran	Solvent Dewaxing	400 bbls.		Under Constr.		Texaco	Badger	Badger
Anglo-Iranian Oil	Isle of Grain, Thames and Medway Estuary, Eng.	Wax Fractionation	60,000 bbls.	$120 million	Planning	1952	Texaco (Lube Unit)	Lummus	Lummus
Anglo-Transvaal Consolidated Investment Co.	Vall River Union, South Africa	Synthetic Gasoline and Diesel Oil Plant		$50-60 million	Contracted			Hydrocarbon Research	
Arabian American Oil Co.	Abqaiq, Saudi Arabia	Crude Oil Stabilizer	300,000 bbls.	$4,800,000	Under Constr.	July-Sept., 1949		Staff and Fluor	Staff and Fluor
Arabian American Oil Co.	Abqaiq, Saudi Arabia	Steam Power Plant, etc.	20,000 kw	$9,400,000	Under Constr.	July-Sept., 1949		Staff and Fluor	Staff and Fluor
Arabian American Oil Co.	Ras Tanura, Saudi Arabia	Add Power Generating Unit	10,000 kw	$1,750,000	Under Constr.	July-Sept., 1949		Staff and Fluor	Staff and Fluor
Arabian American Oil Co.	Ras Tanura, Saudi Arabia	Refinery Additions			Under Constr.	1949		Bechtel	Bechtel
Australian Shell Oil Co.	Geelong, Victoria, Australia	New Refinery		$4.8 million	Under Constr.	1951			

■ CONTINUED ON PAGE 105

How would YOU *measure one constituent of a flowing solution?*

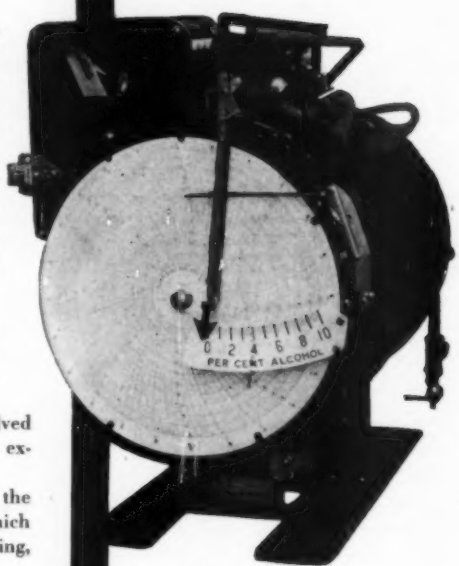
That was the problem in a large alcohol plant—to measure the *net amount of alcohol* in a flowing solution of alcohol and water in varying proportions to and from the recovery units. This type of measurement is easily accomplished with a standard model of the dual type Hagan Ring Balance Flow Meter.

The meter used for this application is shown in the photograph. The high-differential ring measures raw flow; the low-differential ring measures specific gravity. Two of the three pens record these quantities on the chart, and a pointer on the specific gravity pen indicates the percentage of alcohol in the solution at any instant.

A third pen is so linked to the two rings that it records flow compensated for specific gravity—and records it as *net volume of alcohol*. The integrator continuously totalizes this alcohol flow.

This is only one of many problems which are easily solved with this Hagan Ring Balance Meter—and which may be extremely difficult to solve in any other way.

For more detailed information on these meters, just fill in the coupon below, or write us about any specific problem in which you may be interested. Hagan Corporation, Hagan Building, Pittsburgh 30, Pa.



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RING BALANCE FLOW AND PRESSURE INSTRUMENTS
THRUSTORQ FORCE MEASURING DEVICES
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323 FOURTH AVENUE • PITTSBURGH 30, PA.

Please send full information on Hagan Ring Balance Flow Meters. I am particularly interested in the application described below.

_____

_____

NAME _____ POSITION _____

COMPANY _____

STREET AND NUMBER _____

CITY AND STATE _____

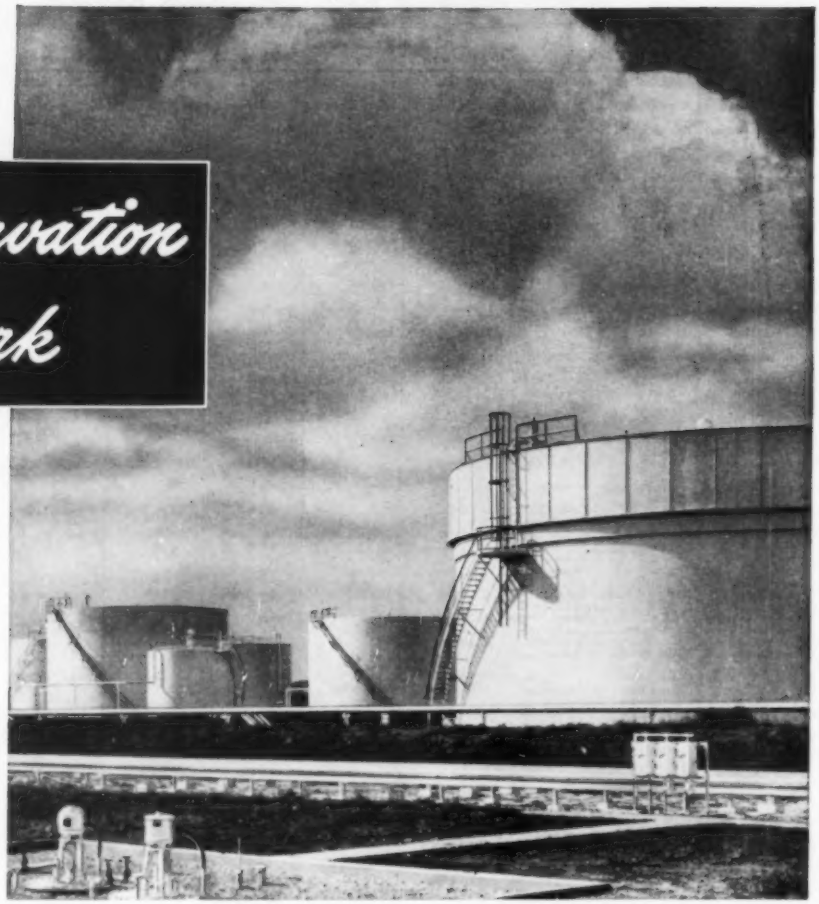
PR-5

REFINERY AND OTHER PLANT CONSTRUCTION (Continued)

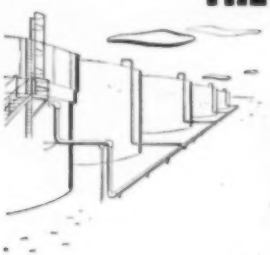
COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Azienda Generale Italiana Petroli	Roma, Italy	Add to Plant	24,000 bbls.	.....	Projected	.....	.....	.....	.....
Bahrein Pet. Co., Ltd.	Bahrein Island	Expansion Program	.....	$8.3 million	Under Constr.	Oct., 1949	.....	U.O.P., Bechtel	International, Bechtel, Inc.
Bahrein Pet. Co., Ltd.	Bahrein Island	Crude Still, Utilities	55,000 bbls.	$9.1 million	Planned	June, 1950	.....	Lummus, Bechtel	.....
Bataafsche Petroleum Maatschappij	Rotterdam-Pernis, Holland	Dewaxing Unit	60,000 bbls.	.....	.....	Completed	Texaco (Duwax)	.....	.....
British-American Oil Co., Ltd.	Montreal, East P.Q., Canada	Cat. Cracking and Cat. Poly	12,300 bbls.	.....	Under Constr.	August, 1949	Kellogg-U.O.P.	Kellogg	Kellogg
British Pet. Chem., Ltd.	Grangemouth, Scotland	Petro-Chem	.....	$30 million	Planned	.....	.....	S. & W. Badger	S. & W. Badger
Burmah Oil Co.	Burma	Furfural Plant Solvent Dewaxing, Wax Manufacturing Units	1,000 bbls.	$600,000	Designing	.....	Texaco	Badger	.....
Burmah Oil Co.	Syriam, Burma	Thermafor Clay Revivification	66 tons	$150,000	Design	1949	Max Miller, Sconny-Vacuum	Max Miller	.....
California-Texas Co., Ltd.	Cartagena, Spain	Refinery	15,000-20,000 bbls.	.....	Proposed	March, 1951	.....	.....	.....
Caltex Pet. Maatschappij, N. V.	Rotterdam, Holland	Complete Refinery	20,000 bbls.	$18 million	Under Constr.	Feb., 1950	.....	McKee, Badger, U.O.P.	McKee
Cie. de Raffinage Shell-Berre	Berre, France	Capacity Increase	47,000 bbls.	.....	Planned	.....	.....	.....	.....
Cie. Francaise de Raffinage	Gonfreville, France	Furfural Refining, Solvent Dewaxing and Wax Fractionation Units	2,500 bbls.	.....	Projected	1951	Texas	.....	.....
Cie. Francaise de Raffinage	Gonfreville, France	Distillation Unit	20,000 bbls.	.....	Under Constr.	1950	.....	Foster-Wheeler	Foster-Wheeler
Cie. Francaise de Raffinage	Provence, France	Topping Unit	20,000 bbls.	.....	Under Constr.	1950	.....	Foster-Wheeler	Foster-Wheeler
Cie. de Raffinage Shell-Berre	Petit Couronne, France	Lube Unit	.....	.....	Planned	.....	.....	.....	.....
Companhia Brasileira de Petróleos S.A.	Rio Grande, Brasil	Topping, Thermal Cracking	3000 bbls.	.....	Authorized	1952	Foster-Wheeler	.....	.....
Compania Espanola de Petroleos S.A. (C.E.P. S.A.)	Canary Islands, Spain	Furfural Refining, Solvent Dewaxing, Wax Fractionation Units	5,000 bbls.	$41½ million	Under Constr.	Early 1950	Texaco, Standard, N.J.	Foster-Wheeler	Foster-Wheeler
Conselho Nacional do Petróleo	Mataripe, Bahia, Brasil	Thermal Cracking Refinery	2500 bbls.	$2.5 million	Under Constr.	Jan., 1950	.....	Kellogg	Kellogg, Staff
Conselho Nacional do Petróleo	.....	Thermal Cracking Refinery	45,000 bbls.	.....	Design	1952	.....	.....	Fiven, Lille, Schneider, Staff
Consolidated Ref., Ltd.	Haifa, Palestine	Crude Plant	80,000 bbls.	.....	Planned	By 1950	.....	Badger	Badger
Consolidated Ref., Ltd.	Haifa, Palestine	General Facilities	.....	.....	Under Design	.....	.....	Badger, Ltd.	.....
Consolidated Ref., Ltd.	Haifa, Palestine	Lube Plant	2,500 bbls.	.....	Designing	.....	Texaco, Juik	Lummus, Kellogg	Lummus, Kellogg
Creole Pet. Corp.	Amauy Bay, Venezuela	Crude Stills	60,000 bbls.	$175 million	Under Constr.	1951	.....	S. O. Devel. Co.	Foster-Wheeler, J. G. White
Creole Pet. Corp.	El Roble Field, Venezuela	Repressuring	.....	.....	Planning	.....	.....	.....	.....
Egyptian Government	Cairo, Egypt	Crude Plant	.....	.....	.....	.....	.....	Lummus	Lummus
Excelsior Refineries	Lloydminster, Alberta, Canada	Moving Refinery	3000 bbls.	$500,000	Under Constr.	Sept., 1949	U.O.P.	U.O.P.	.....
Hi-Way Refineries, Ltd.	Saskatoon, Saskatchewan	Crude Topping Unit	2,000 bbls.	.....	Under Constr.	Dec., 1949	U.O.P.	Ref. Eng.	Ref. Eng.
Hi-Way Refineries, Ltd.	Saskatoon, Saskatchewan	Thermal Cracking Unit	500 bbls.	.....	Under Constr.	Dec., 1949	U.O.P.	Ref. Eng.	Ref. Eng
Imperial Oil, Ltd.	Edmonton, Canada	Increase Capacity	11,000 bbls.	$2½ million	Under Constr.	Sept, 1949	.....	Staff, Barnes	Barnes
Imperial Oil, Ltd.	Leduc Field, Canada	Gas Absorption Plant	24,000 mcf	$6.5 million	Under Constr.	Middle 1950	.....	Braun	Braun
Industrie Chimiche Italiane Petroli	Mantua, Italy	Crude	4,500 bbls.	.....	.....	.....	.....	.....	.....
Kuwait Oil Co.	Kuwait	Topping Unit	30,000 bbls.	$2 million	Under Constr. "Paper Stage"	July, 1949	.....	Badger	Badger
Mediterranean Ref. Co.	Trans-Arabian P.L. Mediterranean Term.	Refinery	.....	.....	.....	.....	.....	.....	.....
Mene Grande Oil Co.	West Guara, Venezuela	Repressuring	.....	.....	.....	.....	.....	.....	.....
National Oil Refineries, Ltd.	Llandarcy, Wales	Crude and Reform.	40,000 bbls.	$36 million	Designing	.....	.....	Badger	Badger
National Oil Refineries, Ltd.	Llandarcy, Wales	Furfural Refining, Solvent Dewaxing, Wax Fractionation Units	1,200 bbls.			.....	Texaco	Badger	Badger
National Oil Refineries, Ltd.	Llandarcy, Wales	SO_2 Solvent Extraction	3,000 bbls.	.....	Contracted	.....	.....	H. W. P.	.....
Pechelbronn S. A. E. M.	Merkwiller, France	Capacity Increase	1,550 bbls.	.....	Authorized	1950	.....	.....	.....
Petro Carbon, Ltd.	Partington, England	Cat. Cracker Lube & Reform	20,000 bbls.	.....	.....	.....	.....	.....	.....
Petro Chem., Ltd.	Partington, England	Petro Chemicals	.....	.....	.....	.....	.....	.....	.....
Petróleos Mexicanos	Poza Rica, Mex.	Gas Purification, Pressure Maintenance, etc.	.....	$13 million	Contracted	Early 1950	.....	McKee	McKee
Petróleos Mexicanos	Salamanca, Mex.	Crude, Gasoil, Cracking	30,000 bbls.	$12 million	Under Constr.	Early 1950	U.O.P.	McKee	McKee
Philblack, Ltd.	Avonmouth, England	Carbon Black Plant	50 million lbs. Yearly	$5 million	Contracted	1950	Phillips	H. W. P.	H. W. P.
Porto Marghera Rfg.	Venice, Italy	Enlarging Crude Unit	.....	.....	Contracted	.....	.....	H. W. P.	H. W. P.
Raffineries de Petrole de la Gironde	Ambes, France	Refinery	13,000 bbls.	$7.8 million	Under Constr.	Early 1950	.....	U.O.P., McKee	McKee
Raffineries Francaises de Petrole de l'Atlantique	St. Nazaire, France	Consolidate Refineries	7,100 bbls.	.....	.....	.....	.....	.....	.....
Raffineries di Napoli, S. P. A.	Naples, Italy	Topping Unit	10,000 bbls.	.....	Under Constr.	Mid 1949	.....	Staff	Staff
Raffineries di Napoli, S. P. A.	Naples, Italy	Solvent Treating	1,000 bbls.	.....	Under Constr.	Early 1950	Texaco	Staff	Staff
Refinaria de Petróleo do Distrito Federal S.A.	Rio de Janeiro, Brazil	Complete Refinery	10,000 bbls.	.....	Authorized	.....	.....	.....	.....
Refinaria e Exploracao de Petróleo	Capuava, S. Paulo, Brazil	Thermal Cracking Refinery	20,000 bbls.	.....	Authorized	.....	.....	Pan American Hydrocarbon Res., Inc.	Czech. Fact. Metal Work & Mech. Constr.

• CONTINUED ON PAGE 107

Conservation at work



THE EXPANSION ROOF STOPS PROFIT LEAKS



Narrowing margins demand optimum operating economy wherever petroleum products are stored. That's why producers, refiners and marketers alike have turned to the Expansion Roof. Here's what it means to them:

ECONOMY . . . The end of evaporation losses
PAYOUT . . . Protection of multiple tank installations through manifolding
PRODUCT QUALITY . . . Maintenance of quality during the storage period
SAFETY . . . Reduced fire hazard, Underwriters' approved
SIMPLICITY . . . No problem of maintenance
PERMANENCE . . . No parts to wear, the Expansion Roof will last the life of the tank

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REFINERY AND OTHER PLANT CONSTRUCTION (Continued)

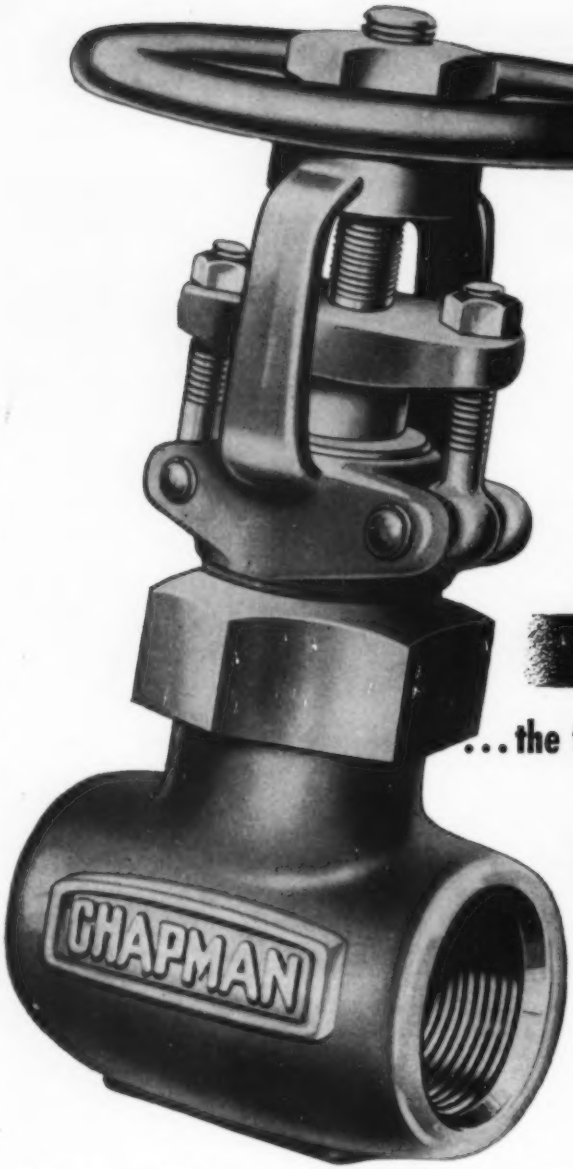
COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Richmond Exploration Co.	Lake Maracaibo, Venezuela	New Refinery	35,000 bbls.		Engineering	June, 1950			
Scottish Oil, Ltd.	Grangemouth, Scotland	Crude	28,000 bbls.	$28 million	Designing				Schneider
Scottish Oils, Ltd.	Grangemouth, Scotland	Cat. Crk.	5,000 bbls.		Planned				
Shell Chem. Corp.	Thornton, Eng.	Petro-chem	Several millions	Under Constr.					
Shell Chem. Corp.	Shell Haven, England	Petro-chem							
Shell Chem. Corp.	Stanlow, Eng.	Petro-chem							
Shell Oil Co. (Venezuela)	Puerto Cardon Venezuela	Complete Refg.	50,000 bbls.		Under Constr.	Early 1949		Lummus	Lummus
Shell Oil Co.	Heysham, Eng.	Remodel & Redesign Crude Plant	30,000 bbls.		Under Constr.	Mid 1949			
Société Generale des Huiles de Pétrole	L'Avera, France	LPG and Gas Stabilising Units			Under Constr.				
Société Generale des Huiles de Pétrole	Dunkirk, France	Crude Reform.	33,000 bbls.		Designing				
Société Generale des Huiles de Pétrole	Dunkirk, France	Furfural Refining, Solvent Dewaxing, Wax Fractionation Units	6,700 bbls.		Designing	1950	Texaco		
Societe Industriel Belgique de Petrole	Antwerp, Belgium	Crude, Cracking Reforming	30,000 bbls.		Designing	Mid., 1951			
Societa per Azioni Raffineria Padana Oli iMinerali	San Matrino di Trecate, Italy	Refinery	10,000 bbls.		Proposed				
Socony-Vacuum Francaise	Notre Dame de Gravenchon, France	Contact Plant			Under Constr.	Mid 1949		Staff	Staff
Socony-Vacuum Francaise	Notre Dame de Gravenchon, France	MEK Unit	1,000 bbls.		Design	Early 1950	Texaco	Lummus	Staff
Socony-Vacuum Francaise	Notre Dame de Gravenchon, France	Solvent Treating	1,100 bbls.		Design	Mid 1950	Juik	Lummus	Staff
Socony-Vacuum Francaise	Notre Dame de Gravenchon, France	Furfural Unit	1,000 bbls.		Under Constr.	Early 1949	Texaco	Staff	Staff
Socony-Vacuum Francaise	Notre Dame de Gravenchon, France	Grease and Compounding Plant			Under Constr.	Early 1950		Staff	Staff
Socony-Vacuum Francaise	Frontignan, France	Capacity Increase	13,500 bbls.		Under Constr.	Aug., 1949		Staff	Staff
Standard Francaise des Pétroles	Port Jerome, France	Capacity Increase	30,000 bbls.		Authorized				
Standard Francaises des Pétroles	Port Jerome, France	Dewaxing Plant	1,000 bbls.		Planned				
Standard Francaises des Pétroles	Port Jerome, France	Deasphalting Plant	2,000 bbls.		Planned				
Stora Kopparberg S. Bergslags Co.	Gotheborg, Sweden	Crude, Ther. Cracking			Under Constr.	Spring, 1949		Lummus	Lummus
Trent Oil Prod. Development Co.	North Shields, England	Crude Plant	11,500 bbls.	$4 to $8 million	Plans approved				
Union Petrol Refinery, Ltd.	Johannesburg, Union of South Africa	New Refinery		$20 million	Projected				
Venezuela Gulf Refining Co.	Puerto la Cruz, Venezuela	Refinery	30,000 bbls.		Under Constr.	July, 1950		Lummus	Lummus
Venezuelan Pet. Co. (Sinclair)	Puerto la Cruz, Venezuela	Refinery	35,000 bbls.		Under Constr.			Frederick Snare Corp.	Frederick Snare Corp.
Yacimientos Petroliferos Fiscales	Buenos Aires, Argentina	New Refinery	28,000 bbls.		Engineering	Late 1950		Kellogg	Kellogg
Yacimientos Petroliferos Fiscales	La Plata, Argentina	Crude Topping, Gaso Treating	50,000 bbls.	$2.8 million	Under Constr.	Early 1949		Houdry Process Cat. Constr.	Cat. Constr
Yacimientos Petrolijeros Fiscales Bolivianos	Sucre, Bolivia	Crude Plant	3,000 bbls.			2nd Qtr., 1949		Foster-Wheeler	Foster-Wheeler
YPF Bolivianos	Cochabamba Bolivia	Topping & Reforming Units	5,000 bbls.			1st Qtr., 1950		Foster-Wheeler	Foster-Wheeler

* First appearance in tabulation. † Added capacity.

Note—Badger—E. B. Badger and Sons. Barnes—W. M. Barnes & Co. Bechtel—Bechtel Corp. Bellows—W. S. Bellows Co. Braun—C. F. Braun Co. Brown Eng.—Brown Engineering Co. Brown & Root—Brown & Root Construction Co. Cat. Constr.—Catalytic Construction Co. Chem Constr.—Chemical Construction Co. Clark's Clark's Construction and Engineering Co. Delta—Delta Engineering Corp. Fresser—Dresser Engineering Corp. E. & A.—Ebrhart & Arthur, Inc. Fish Eng.—Fish Engineering Corp. Fluor—Fluor Corp. Foster-Wheeler—Foster-Wheeler Corp. Gaso. Plant—Gasoline Plant Construction Co. General American—General American Transportation Co. Houdry—Houdry Corp. Hudson—Hudson Engineering Corp. H. W. P.—Head Wrightson Processes, Ltd. Hydro Res.—Hydrocarbon Research, Inc. Ind. Eng.—Industrial Engineers, Inc. J. & L. Constr.—Construction Division, Jones & Laughlin Supply Co. Kellogg—M. W. Kellogg Co. Koch—Koch Engineering Co. Koppers—Koppers Co., Inc. Leonard—Leonard Construction Co. Lummus—The Lummus Co. Mason—Mason Brothers Construction Co. McKee—Arthur G. McKee Co. Max Miller—Max B. Miller & Co. Parsons—The Ralph M. Parsons Co. Pet. Eng.—Petroleum Engineering, Inc. Petro—Petroleum Rectifying Co. Pritchard—J. F. Pritchard Co. Process Eng.—Process Engineers, Inc. Process Constr.—Process Construction Co. Ref. Eng.—Refinery Engineering Co. Ref. Maint—Refinery Maintenance Co, Inc. Rust Eng.—Rust Engineering Co. S. O. D.—Standard Oil Development Co. State Eng.—State Engineering Co. Stearns-Roger—Stearns-Roger Manufacturing Co. Stone & Webster—Stone & Webster Construction Co. Tellepsen—Tellepsen Construction Co. Texaco—Texaco Development Co. U. O. P.—Universal Oil Products Co. Walco—Walco Engineering Wohfeld—Wohfeld Construction Co. Equally owned by California Texas Corp. and Socony-Vacuum Oil Co., Inc.

Notes on Late Projects

Salt Lake Refining Company, Standard Oil Company of California subsidiary, is to expand its Salt Lake City plant, bringing capacity up to 24,000 barrels daily. Cost will be $10 million and new equipment includes catalytic cracking facilities, additional storage, loading racks, feeder lines, etc. . . . **Cities Service Oil Company** has awarded contract to Sumner S. Sollitt and Company for modern $4 million compound plant at Cicero, Ill. With completion due in early 1950, the plant is designed to compound and blend more than 23 million gallons of lube oil per year, the blending stocks coming from the Cit-Con Oil Corporation plant at Lake Charles, La. . . . **Freeport Sulphur Company** will own and operate a sulfur-recovery plant to be built by The Grinder Corporation, Louisville, Ky., within the grounds of The Texas Company's Eagle Point Refinery, Westville, N.J. Forty tons of sulfur daily will be recovered from hydrogen sulfide contained in the refinery's waste gases, but the main purpose is to minimize atmospheric pollution . . . Foreignwise, two items of interest appeared during the month: 1) **The Dominican Republic** government is to build a $15 million oil refinery, capacity 25,000 barrels crude oil daily to process crude imported from foreign sources. International Industrial Consultants, S.A. will construct the plant, completion to be within two years, equipment to cost $9¼ million. . . . 2) **Raffinerie Belge de Petroles S.A.** has underway a $2 million construction program at its Antwerp, Belgium, refinery and its Zeebrugge bunkering station. . . . Two gasoil cracking units, a naphtha reforming unit, and a complete steam plant has been purchased from Caminol Company and W. M. Barnes Company is dismantling, reconditioning and re-erecting the equipment in Belgium with plant operation scheduled to begin late next fall.



Chapman List 960

. . . the forged steel gate valve that's

Built to Take it

Chapman was thinking of *your needs* when it designed this sturdy gate valve. That's why there are so many features that mean lower maintenance costs . . . longer years of useful life.

Take for instance the materials. There's tough forged steel in body and yoke . . . stainless steel in seat rings and plugs. Discs are not just hardened . . . they are superhardened by Malcomizing.

But that's only part of it. This valve is designed so you can repack it under full pressure . . . so that yoke threads are protected against rust and corrosion. And designed without gaskets to blow.

It's available in sizes from ¼" to 2" . . . carbon steel for pressures to 800 pounds; alloy steel for pressures to 1000 pounds at 750° F. For higher pressures, specify List 990.

The CHAPMAN Valve Mfg. Co.
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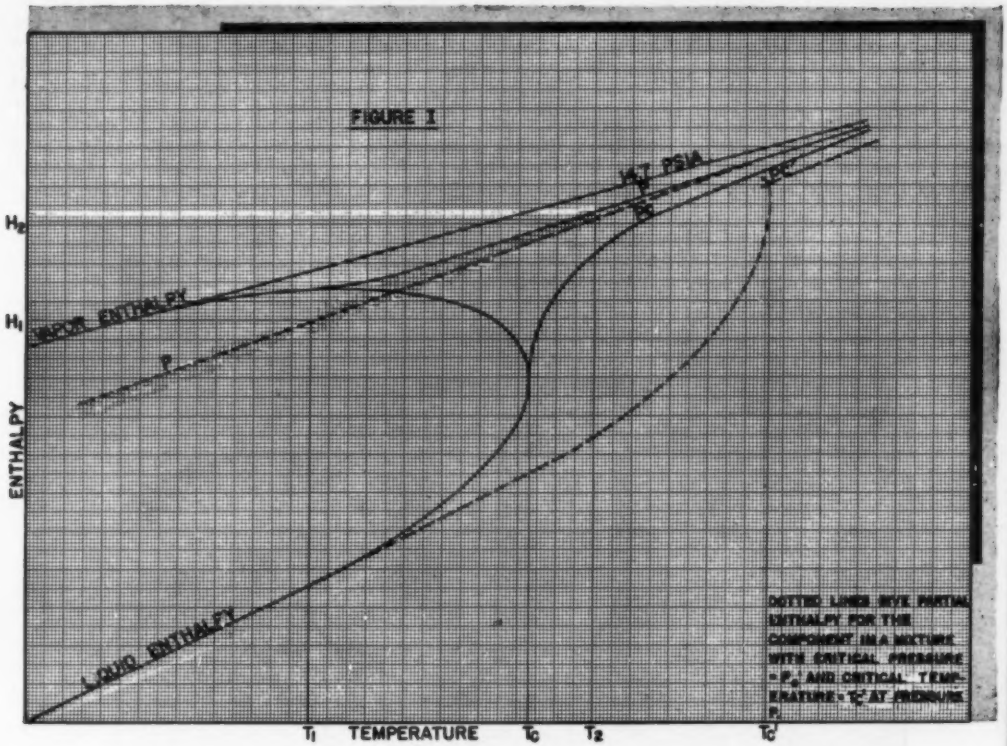


Partial Enthalpies of Light Hydrocarbons

"... Today's Processes Are Demanding More and More Exact Calculations"

H. F. PETERS
Scientific Design Company, Inc., New York

The purpose of this discussion is to integrate heat and equilibrium data and provide the designer of light hydrocarbon towers with an additional tool to improve the accuracy of his work. In making process calculations on fractionating columns such as occur in ethylene recovery plants, some components exist in the liquid phase at temperatures higher than their critical

THE DESIGN of light hydrocarbon fractionating towers is rapidly approaching an exact science. This is due to the profusion of methods of calculating reflux ratios, number of theoretical trays, over-all tray efficiencies, etc., which has been published in the past ten years along with vapor-liquid equilibrium data, and supporting plant data. In general, it may be stated that design engineering companies and refiners can now make process designs and install equipment with no more than the desired "excess capacity."

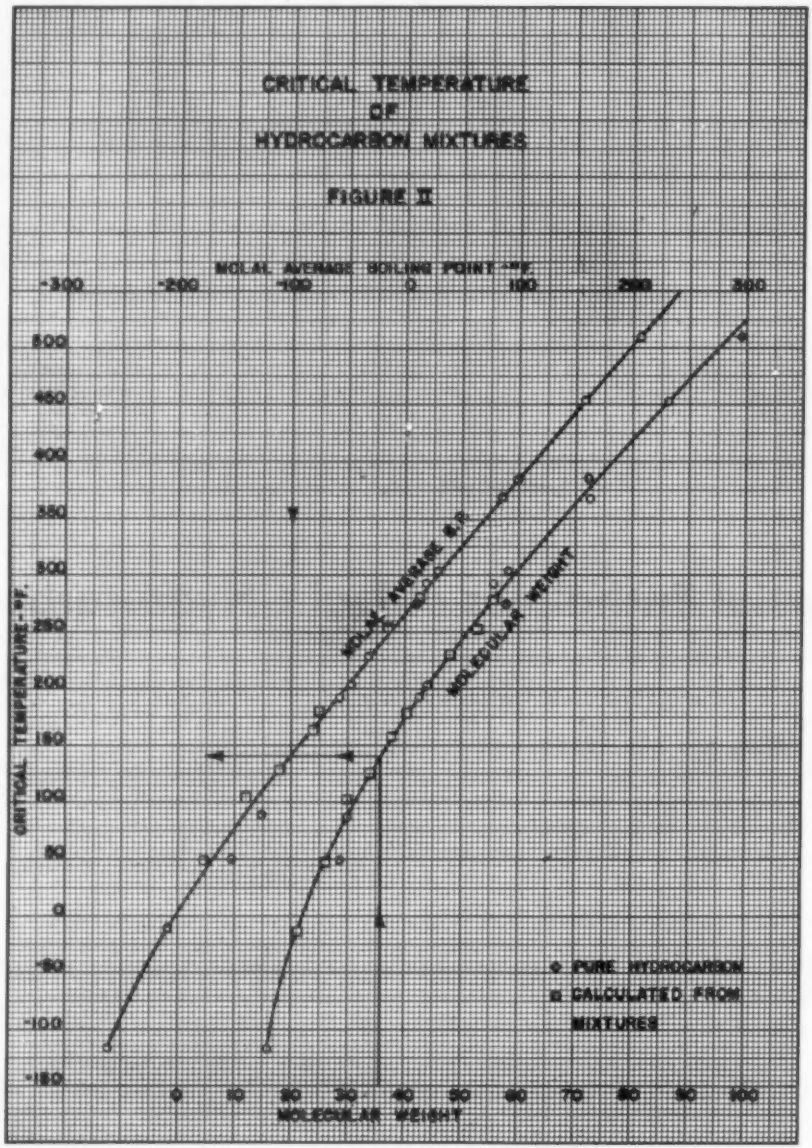
In the past, the prime requirement for tower design was good vapor-liquid equilibrium data; feed preheat, condenser and reboiler duties could be calculated from the specific and latent heats of the mixture. Today's processes are demanding more and more exact calculations, due mainly to the high and low extremes in temperature and pressure resorted to for reaction and separation and the attendant penalties on the economics of the process due to overdesign.

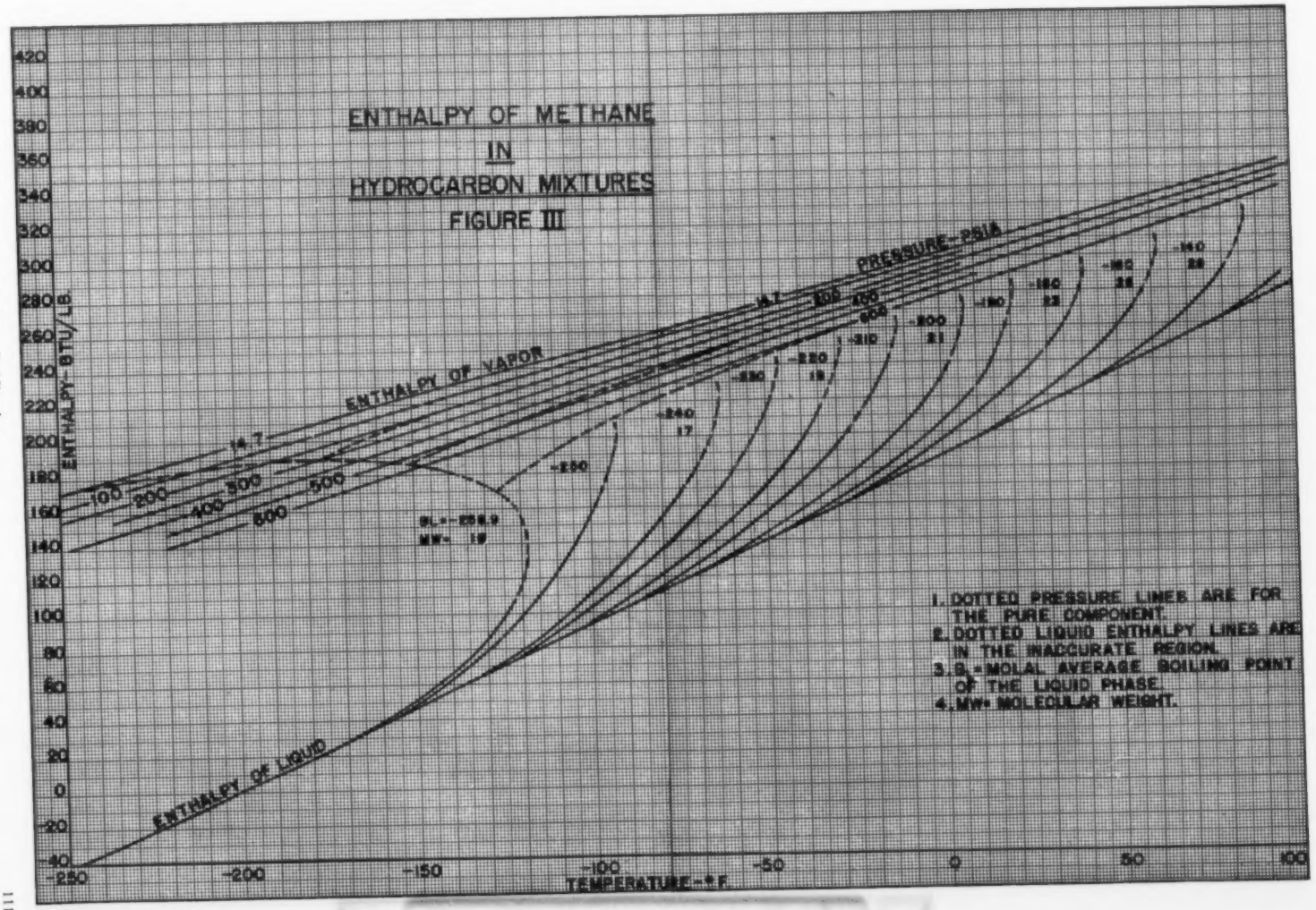
The use of equilibrium constants selected as a function of the reduced properties or boiling range of the liquid and vapor phases is necessary for accurate high-pressure or low-temperature work. The use of total heat charts is mandatory for high-pressure or low-temperature designs involving reaction or separation. Moreover, applying total heats of the individual hydrocarbons is necessary to keep enthalpy accuracy commensurate with the equilibrium data. Molecular weight-enthalpy correlations are not accurate enough for designing demethanizers, deethylenizers, isobutane towers, and many others.

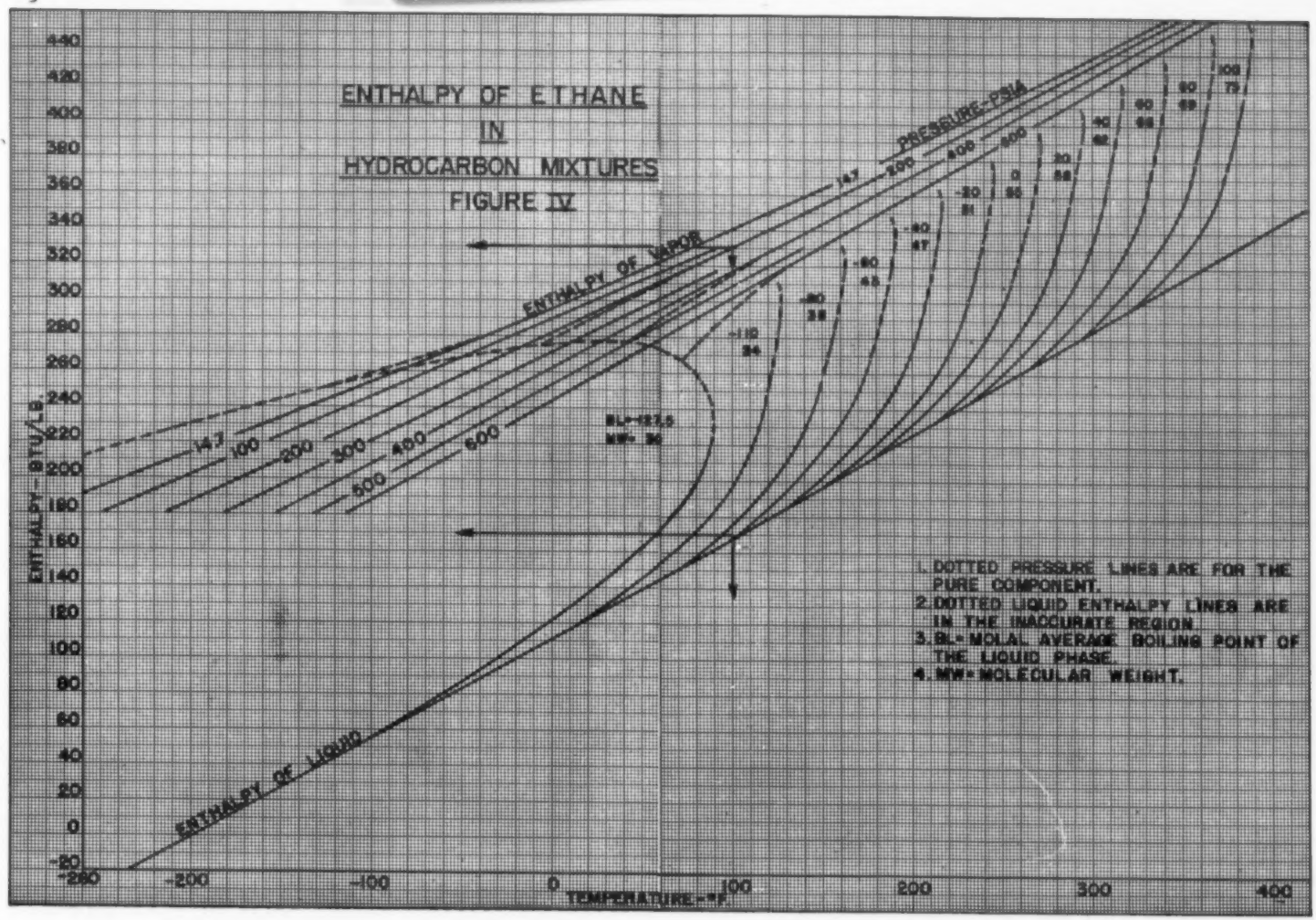
temperatures; and some components exist in the vapor phase above the saturation pressure of the component. Heat contents for these two conditions cannot be read from the enthalpy chart for the pure hydrocarbon.

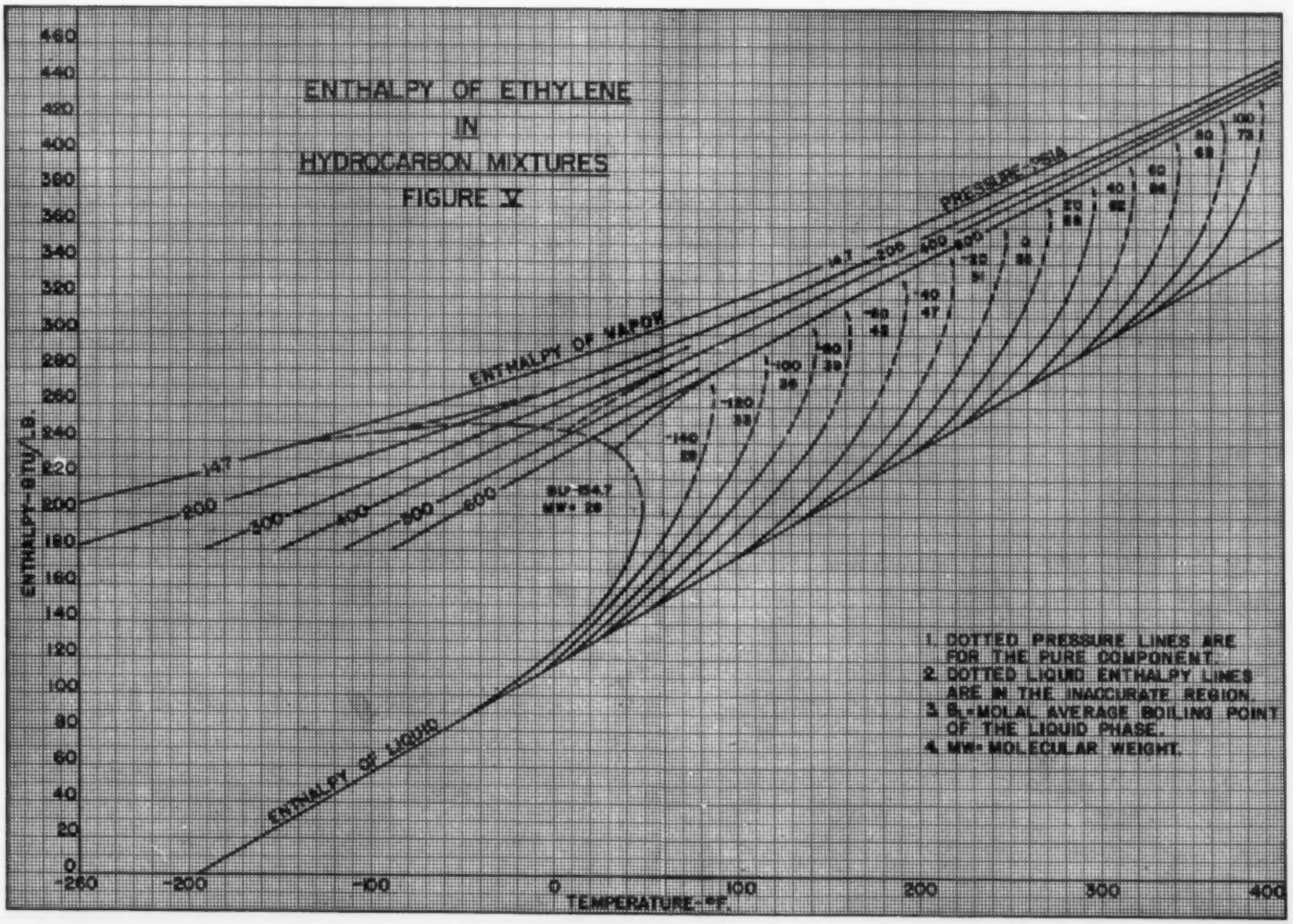
Partial enthalpy is defined as the enthalpy of a pure component in a mixture. The enthalpy of a mixture is the sum of the partial enthalpies of its components. Several methods have been presented for calculating the enthalpies of gas and liquid mixtures. The methods are somewhat alike and hinge upon first calculating the enthalpy of the mixture as a gas in the ideal state at the temperature considered. This is done by summing up enthalpies of components. For gases, one then applies a correction for the effect of pressure, based on the pseudo-critical properties of the mixture. For liquids, the scheme is even more burdensome and subject to considerable error. One assumes that the liquid is formed by compressing the vapor from the ideal state to a pseudo pressure, taken as the vapor pressure of a

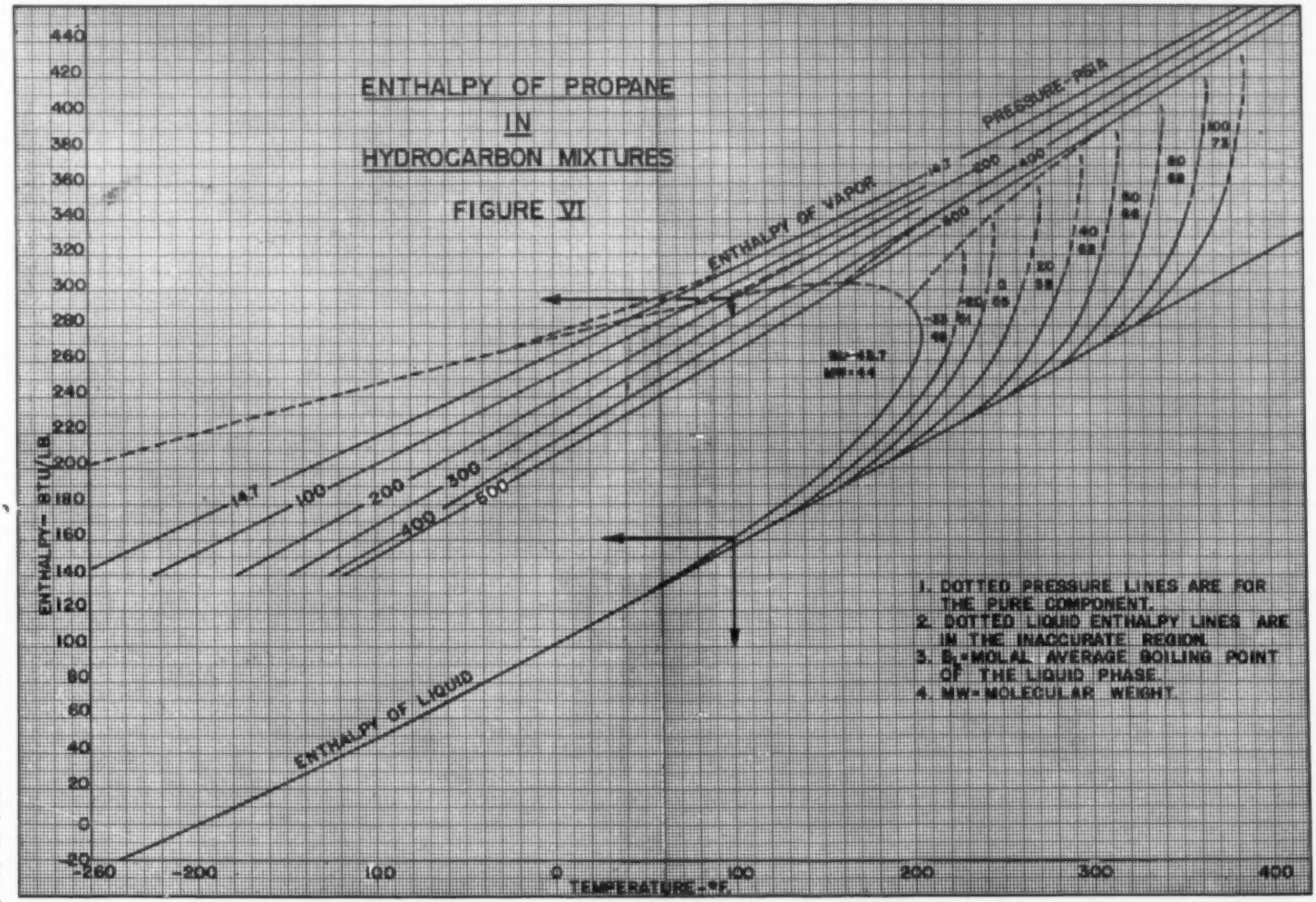
Discussion concluded on page 116.
Note charts on intervening five pages.

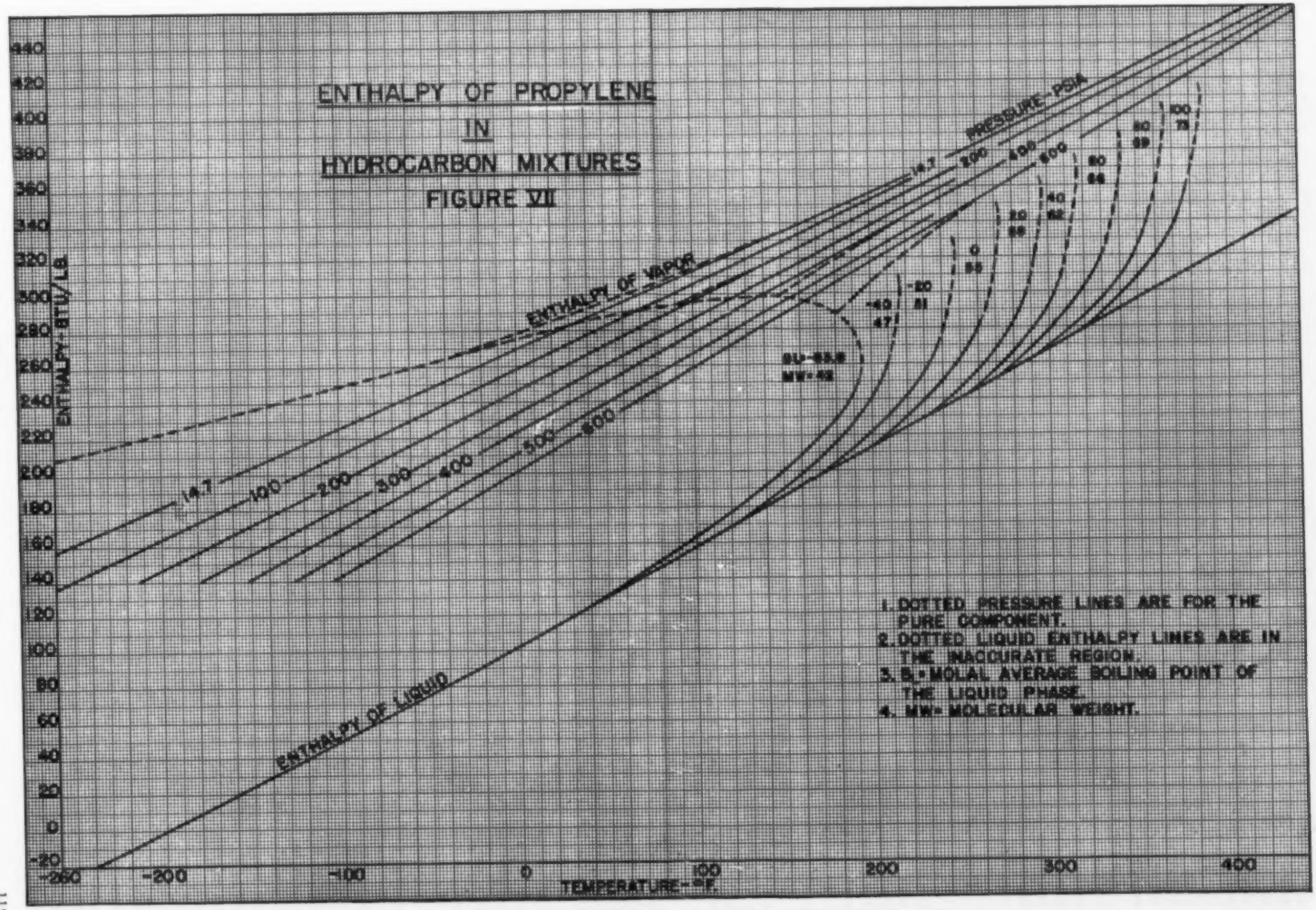



ENTHALPY OF METHANE
IN
HYDROCARBON MIXTURES
FIGURE III
ENTHALPY - BTU/LB
TEMPERATURE - °F
PRESSURE - PSIA
ENTHALPY OF VAPOR
ENTHALPY OF LIQUID
14.7
100
200
300
400
500
600
-250
-240
17
-230
-220
18
-210
-200
21
-190
-180
23
-160
26
-140
28
B.P. = -258.9
MW = 19
1. DOTTED PRESSURE LINES ARE FOR THE PURE COMPONENT.
2. DOTTED LIQUID ENTHALPY LINES ARE IN THE INACCURATE REGION.
3. B.P. = MOLAL AVERAGE BOILING POINT OF THE LIQUID PHASE.
4. MW = MOLECULAR WEIGHT.


ENTHALPY OF ETHANE
IN
HYDROCARBON MIXTURES
FIGURE IV
PRESSURE-PSIA
147
100
200
300
400
500
600
ENTHALPY OF VAPOR
ENTHALPY OF LIQUID
BL=-127.5
MW= 30
-110
34
-80
38
-60
43
-40
47
-20
51
0
55
20
58
40
62
60
66
80
69
100
72
ENTHALPY - B.T.U./LB.
TEMPERATURE - °F.
-200
-100
0
100
200
300
400
1. DOTTED PRESSURE LINES ARE FOR THE PURE COMPONENT.
2. DOTTED LIQUID ENTHALPY LINES ARE IN THE INACCURATE REGION.
3. BL = MOLAL AVERAGE BOILING POINT OF THE LIQUID PHASE.
4. MW = MOLECULAR WEIGHT.


ENTHALPY OF ETHYLENE
IN
HYDROCARBON MIXTURES
FIGURE V
ENTHALPY OF VAPOR
ENTHALPY OF LIQUID
PRESSURE-PSIA
ENTHALPY-BTU/LB.
TEMPERATURE-°F.
1. DOTTED PRESSURE LINES ARE FOR THE PURE COMPONENT.
2. DOTTED LIQUID ENTHALPY LINES ARE IN THE INACCURATE REGION.
3. B_L = MOLAL AVERAGE BOILING POINT OF THE LIQUID PHASE.
4. MW = MOLECULAR WEIGHT.


ENTHALPY OF PROPANE
IN
HYDROCARBON MIXTURES
FIGURE VI
ENTHALPY - BTU/LB.
TEMPERATURE - °F.
ENTHALPY OF VAPOR
ENTHALPY OF LIQUID
PRESSURE - PSIA
14.7
100
200
300
400
500
Sb=45.7
MW=44
1. DOTTED PRESSURE LINES ARE FOR THE PURE COMPONENT.
2. DOTTED LIQUID ENTHALPY LINES ARE IN THE INACCURATE REGION.
3. Sb = MOLAL AVERAGE BOILING POINT OF THE LIQUID PHASE.
4. MW = MOLECULAR WEIGHT.


ENTHALPY OF PROPYLENE
IN
HYDROCARBON MIXTURES
FIGURE VII
ENTHALPY - BTU/LB
TEMPERATURE - °F
PRESSURE - PSIA
ENTHALPY OF VAPOR
ENTHALPY OF LIQUID
14.7
100
200
300
400
500
600
-40
47
-20
51
0
55
20
58
40
62
60
66
80
69
100
73
80-85.8
MW-42
1. DOTTED PRESSURE LINES ARE FOR THE PURE COMPONENT.
2. DOTTED LIQUID ENTHALPY LINES ARE IN THE INACCURATE REGION.
3. B.= MOLAL AVERAGE BOILING POINT OF THE LIQUID PHASE.
4. MW= MOLECULAR WEIGHT.

compound with the same critical properties, liquid density and latent heat as the pseudo properties of the mixture. Fictitious condensation now occurs releasing a pseudo latent heat; this is subtracted from the aforementioned enthalpy. The final step is to compress the liquid to the pressure under consideration and adjust the enthalpy.

For the designer making tray calculations, heat balances around reactors, exchangers, etc., this procedure is impractical. Charts that will give partial enthalpies of each component in the mixture under any conditions are required.

Form of the Enthalpy Charts

Partial enthalpy charts must be a function of temperature and pressure with one or more thermodynamic properties of the mixture as variables. The general shape of partial enthalpy curves is based on the following:

1) A distinct partial enthalpy curve exists for each mixture encountered.

2) Liquid partial enthalpy curves are tangential to the true critical temperature of the mixture at the critical pressure of the mixture, and at this temperature the latent heat of each component in the liquid phase is zero.

3) Above the pure component critical temperature, vapor enthalpies of the pure component may be used as partial vapor enthalpies and partial liquid enthalpies may be calculated from the latent heat of vaporization.

4) Below the pure component critical temperature, liquid enthalpies may be used as the partial liquid enthalpies and the partial vapor enthalpies may be calculated from the latent heat of vaporization.

From the above considerations, partial enthalpy envelopes have the same general form as the envelope for the pure component. Refer to Figure I. The enthalpy curve for the pure component is shown solid. The partial enthalpy curve for the component in a mixture is shown dotted. T_c and P_c are the pure component critical temperature and pressure respectively. T_c, and P_c, are the criticals for the mixture and the partial enthalpy at temperature T_1 is H_1 at pressure P. The partial enthalpy at temperature T_2 is H_2 at pressure P. The partial liquid enthalpy is reduced by these premises to a family of curves with critical temperature of the liquid phase as a parameter. The partial vapor enthalpy is merely a family of pressure lines.

Calculation of Intermediate Points

To make a partial enthalpy chart for a component, it is necessary to calculate the complete liquid portion of the partial enthalpy envelopes and only extended vapor enthalpies. Conditions at the critical temperature and pressure of a particular mixture cannot be accurately calculated but this is of no importance since an actual design would not be made in this region. This portion of the curves is shown dotted on the attached charts.

A set of vapor-liquid equilibrium constants based on the molal average boiling point of both phases is used to calculate latent heats. These constants are based on observed data and calculations involving a basic equation of state. Latent heats are calculated with the general equilibrium equation:

$$\frac{d \ln K_p}{d T} = \frac{\Delta H}{RT^2} \qquad (1)$$

which is derived in several texts, and is valid for both chemical and physical equilibria. The well known Clausius-Clapeyron equation is a special case of the general equation. Integrating,

$$\ln \frac{K_2}{K_1} = \frac{\Delta H}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right) \qquad (2)$$

This equation relates the latent heat to the basic equation of state and gives zero latent heat at the critical temperature of the mixture.

As previously stated, the only parameter required to establish partial enthalpies is critical temperature. Since getting critical temperatures would require extra calculations for the tower designer, a correlation has been made to test the feasibility of substituting molal average boiling points of mixtures encountered in tower design. Reference to Figure II will show that calculation of the critical temperature is not warranted. To cover cases where molal average boiling points are not normally calculated, the corresponding molecular weight is given.

At this point it is well to recognize that whereas critical temperature sets the confines and endpoint of the partial enthalpy curves, the particular components present in the mixture set the true path leading to the endpoint. If one feels that molal average boiling points or molecular weights are not representative of the critical temperatures of his mixtures he can insure accuracy by calculating the true criticals of the mixtures and installing liquid enthalpy curves on the charts presented herewith.

Example and Comparison With Other Methods

Refer to Figures III to VII for partial enthalpy charts for some light hydrocarbons. A chart for hydrogen is not included since all vapor enthalpies can be taken from the pure component chart and there is usually not enough weight of this component in the liquid phase to justify a chart.

To obtain enthalpies of ethane in a mixture of 42 molecular weight refer to Figure IV. The enthalpy for ethane as vapor at 100° F. and 190 psia. is taken from Figure IV as 330 Btu./lb. The liquid enthalpy at this temperature is 170 Btu./lb.

Hougen and Watson[1] calculate some enthalpies for a natural gasoline depropanizer reflux stream. Enthalpies are obtained from specific heats, ideal gas heats, etc., as previously described and referred to the ideal gaseous state at 60° F. The molecular weight of this mixture is 41.9.

The Problem:

Calculate the enthalpy of a depropanizer reflux stream containing 1.5 mol percent methane, 12.0 mol percent ethane and 86.5 mol percent propane (a) as vapor at 175 psi. and 100° F., (b) as liquid at 300 psi. and 100° F. Express the enthalpies in Btu./lb. relative to the ideal gaseous state at 60° F.

Solution:

Simply calculate a weight average heat content for the stream under the stated conditions. Figures III, IV and VI are used for this problem.

Tabulated Calculation:

COMPONENT	Mole Fraction	Mol. Weight	Pounds	HEAT CONTENT—Btu./Lb. (V) 60°–0 Psig.	Btu./Lb. X Lbs.	(V) 100°–175 Psig.	Btu./Lb. X Lbs.	(L) 100°	Btu./Lb. X Lbs.
Methane	.015	16	.24	333	80	350	84	283	68
Ethane	.120	30	3.60	321	1155	330	1190	170	612
Propane	.865	44	38.06	297	11300	295	11200	161	6120
	1.00	41.9	41.9	300	12535	297	12474	162	6800

Answers:

(a) Enthalpy is 297 — 300 = — 3.0 Btu./lb. referred to 60° F.

(b) Enthalpy is 162 — 300 = — 138 Btu./lb. referred to 60° F.

Hougen and Watson calculate — 3.05 and — 137 Btu./lb. respectively.

REFERENCE

[1] O. A. Hougen & K. M. Watson, "Chemical Process Principles," Part II, Pages 612, 613.

High-Pressure Absorbers and Dehydration Area of the Dubach, La., Gasoline Plant Built by Southwest Gas Producing Company, Inc., and W. C. Feazel.

Ethane and Propane Separation Greatly Simplified at Dubach

C. B. AMES and T. D. TABBERT
The Fish Engineering Corporation, Houston

SOUTHWEST Gas Producing Company, Inc., and W. C. Feazel, Shreveport, La., have recently completed their Dubach gasoline plant, located 11 miles north of Ruston, La. and just outside the city limits of Dubach, La.

High-pressure wet gas is gathered from the joint holdings of the above owners and others in the Hico Field near Dubach, Lincoln Parish, La. Wells supplying the wet gas have a flowing pressure of approximately 2700 pounds. Normal operating pressure of the plant is 900 pounds with inlet gas being reduced through chokes on individual wells, and a final pressure reducing regulator station at plant inlet.

USE OF LOW molecular weight oil in combination with refrigeration and dehydration for the oil and the wet gas before high pressure absorption, plus 80 percent propane extraction, renders the Dubach plant's process design description by the authors unusually interesting to engineers and operators of gasoline plants.

Plant features include low oil circulation, which reduced sizes of oil coolers, vent tanks, and pumps about 50 percent over conventional plants of equivalent capacity, and reduced the oil stripping temperature to a maximum of 410° F. Separation of ethane and propane in this plant is greatly simplified.

The plant is designed to initially handle 90 million standard cubic feet of natural gas per day at a normal operating pressure of 900 psi., with a maximum design pressure of 1050 psi., recovering 80 percent of the propane and approximately 100 percent of all the heavier components, resulting in a total production of 230,000 gallons per day. For future operation the gas handling equipment in the plant was so designed that the volume of gas can be increased to 120 million standard cubic feet per day, reducing the propane recovery to 60 percent and producing 295,000 gallons per day total products.

This plant is unusual from a design standpoint in that it incorporates the use of low molecular weight oil in combination with refrigeration and dehydration for both oil and wet gas before high pressure absorption. The oil circulation is reduced to less than half that required for conventional high pressure plants using a high molecular weight oil. The small oil circulation alone reduced the size of the oil coolers, exchangers, pumps and vent tanks approximately 50 percent. In addition, necessary stripping could be obtained by raising the light oil to a maximum temperature of 410° F. which corresponds to usual high pressure plant oil temperatures of 500 to 550° F. This lowering of the temperature level of the oil not only further reduced the size of the oil exchange equipment, but materially reduced the size of the stills and overhead condensers.

The use of refrigerated oil has one more major advantage, the increased selectivity of high-pressure propane absorption. By lowering the oil temperature to 60° F. compared with a normal plant oil temperature of 90° F., the undesirable fixed gas pickup was reduced 25 percent. Anyone acquainted with process design fully appreciates the savings derived from such a re-

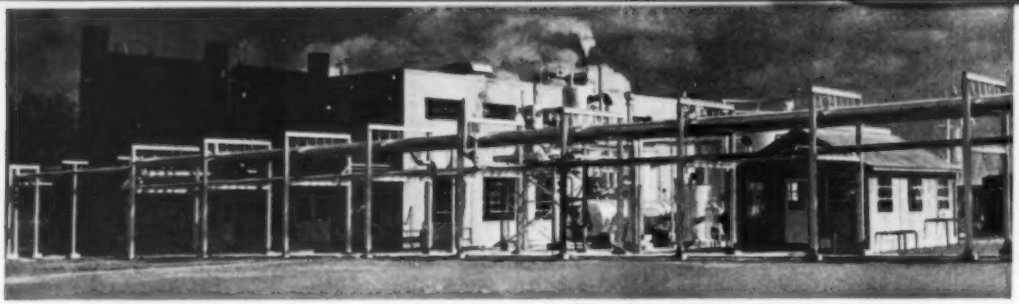


Photo shows power plant at the Southwest-Feazel gasoline plant recently completed at Duboch, La.

duction in the methane and ethane quantity leaving the primary absorbers. Not only are the sizes of the still, reabsorber, condensers and recompressors decreased, but the basic problem of separating ethane from propane is greatly simplified.

Flow diagram, Figure 1, shows the oil and gas flow in the absorption and distillation section of the plant. An inlet surge tank has been installed and provided with a long range level control for handling surges is distillate entering with the wet gas. The wet gas is then dehydrated with the use of a conventional Florite contactor while water is removed from the distillate with a glass wool filter. The distillate from this filter tank is then comingled with dehydrated wet gas to increase the quantity of condensation occurring in the main high pressure chiller. The total stream of gas and liquid from the chiller passes through a separator where the distillate is drawn off to the fractionation system, which will be discussed later, while the cold wet gas enters the absorbers.

The gas is stripped in three high-pressure absorbers by the use of an oil having a mean molecular weight of 155 and a gravity of 49° API. Refrigeration of this oil stream to 60° F. is necessary to prevent excessive loss due to retrograde vaporization. Gas leaving the top of the absorbers passes through the residue scrubber and thence to sales. The cold rich oil leaving the base of the absorbers is flashed through two stages, the first at 425 psi. and the second at 200 psi. These flashed vapors from the 425 psi. stage, containing slight amounts of recoverable products, are recompressed and recycled through the main absorbers. The vapors from the 200 psi. stage are treated in the reabsorber operating at 150 psi.

The rich oil from the 200 psi. vent tank flows through the oil to oil exchangers and into a hot vent tank operating at 175 psi. and 320° F. The generated vapors are passed through a vent condenser where the heavier ends condense, the noncondensed vapors passing into the reabsorber. The small amount of condensed liquid of high end point is inserted in the top trays of the high pressure still serving as partial reflux. This vent system is not new but has been found to be an extremely simple and economical

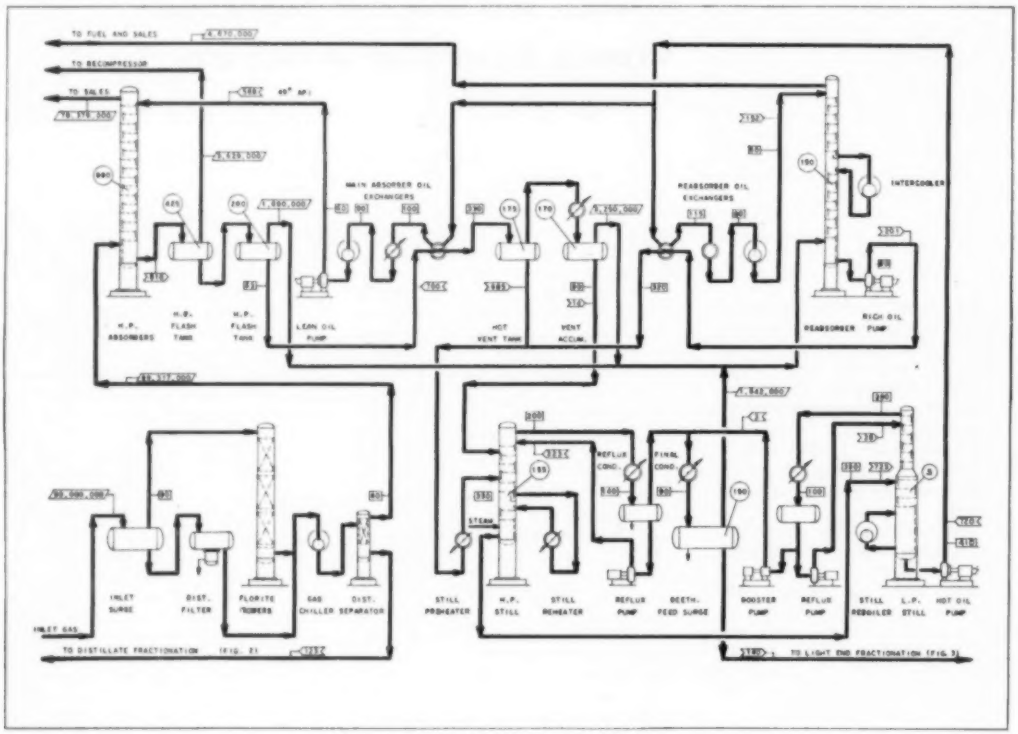


Figure 1. Process Flow Absorption and Distillation

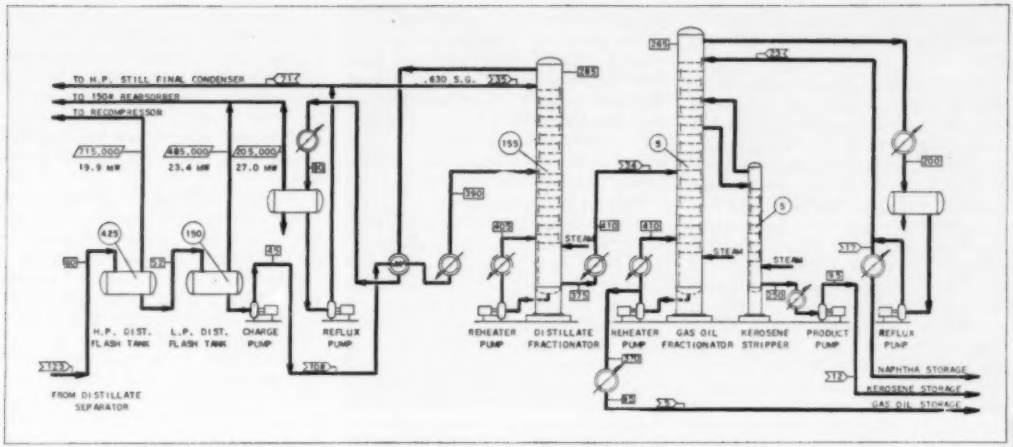


Figure 2. Process Flow Distillate Fractionation

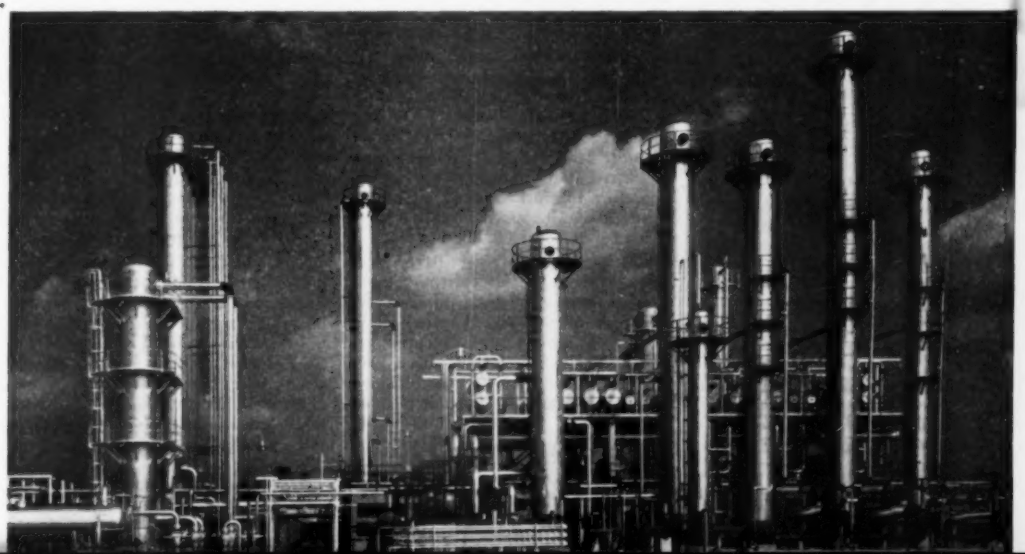
method of eliminating ethane from a high propane recovery plant. Rich oil from the bottom of the 150-pound reabsorber is pumped through a separate bank of oil to oil exchangers and comingled with the main oil stream from the hot vent tank. The total oil stream then passes through a steam preheater, where it is raised to 390° F. before entering the high-pressure still.

In the high-pressure still, agitation steam is limited to that required to strip the rich oil completely through the butane fraction. The partly stripped oil from the high-pressure still flows to the low-pressure still where the balance of the absorbed components are removed from the oil. By operating this still at approximately atmospheric pressure as a fractionator the lean oil is completely dehydrated. A steam heated reboiler is provided on the base of this still for raising the oil temperature to 410°, thus using the hot hydrocarbon vapors to strip the gasoline fraction.

The lean oil from the base of the low-pressure still is pumped through the oil to oil exchangers, oil coolers and oil chillers, with a portion of the cold oil piped direct to the reabsorber, the remainder entering the suction of the high-pressure lean oil pump. This pump returns the oil over the high-pressure absorbers, completing the cycle.

The high-pressure still overhead is partly condensed at the relatively high temperature level of 140° F. and a separate reflux accumulator employed. This is now common practice for removing the large reflux heat load with a high mean temperature difference, thus saving condenser surface. Such a system is not justified for the low-pressure still since the overhead heat load is so small that practically minimum size condensers are utilized. The vapor and liquid stream from the high-pressure still reflux accumulator is combined with the liquid streams from the low-pressure still overhead accumulator and the distillate fractionator overhead accumulator, passing through the high-pressure still final condenser into the deethanizer feed surge tank. By introducing these heavy constituents into the light overhead from the high-pressure still, a high percentage of condensation is obtained. The small amount of noncondensed vapors flows to the reabsorber. A single 48-inch reabsorber handles a total

Photo below shows the fractionating facilities for distillate and light ends at the Dubach, La., gasoline plant.



of five separate vent gas streams, greatly simplifying the over-all plant flow.

Flow diagram, Figure 2, shows the flow through the distillate section of the plant. Raw distillate is flashed first at 425 pounds, the vapors combining with those from the high pressure cold rich oil flash passing to the recompressor. Distillate is flashed further at 150 pounds, these vapors passing to the reabsorber. The flashed distillate is pumped to the 155-pound distillate fractionator where all components through the gasoline fraction are removed as the overhead product. Overhead vapors are exchanged with the feed for a substantial heat salvage. The very small amount of noncondensed overhead vapor flows to the reabsorber, while the condensed liquid stream is pumped directly to the high pressure still final condenser.

The bottom product from the distillate fractionator flows to the gas oil fractionator where gas oil is removed as the bottom product, kerosine as a side cut and naphtha as overhead. It is important to note that this sharp separation is made with the use of steam heating and steam stripping, completely eliminating the use of any direct fired heaters in the plant. This column also serves the very important function of purifying the main oil absorption system. This is accomplished by passing a small stream from the discharge of the hot lean oil pumps into the feed of this column, where the heavy ends are removed as part of the gas oil product and makeup to the main oil system is provided from the kerosine product.

Flow diagram, Figure 3, illustrates the light end fractionation plant. This is the cascade type in which the final gasoline product passes through the columns in series. The simplicity of flow and over-all efficiency of operation have caused this system to be most widely used. The raw product from the high pressure still final accumulator is pumped to the deethanizer. The presence of refrigeration in the plant allowed the overhead product from the deethanizer to be chilled to 60° F., practically eliminating the loss of propane in the overhead product. The bottoms from the deethanizer are pressured into the depropanizer where specification propane is removed as the overhead product. The bottoms from the depropanizer are pressured to the debutanizer where specification natural gasoline is removed as the bottom product and the remaining mixed butanes pass overhead. Bottoms from the debutanizer are exchanged against the raw feed furnishing a major portion of the preheat necessary for proper deethanizer operation.

The plant site is accessible by one-quarter mile of gravel surfaced road from Highway 167. The main line of the Rock Island Railroad parallels the property and spur tracks are available. The plant has been connected into one of the major gas transmission systems and a large product pipe line.

General arrangement of the plant follows conventional methods which are widely used for other plants of this type. Special consideration was given to the location of the boiler plant and the cooling tower in relation to the prevailing winds; the arrangement of the process area was designed, using a distillation structure and closed cooling units in order to conserve piping, provide ample liquid suction head to all pumps, elevate condensers as required and, in general, to permit ease of operation.

The entire plant area occupies two distinct levels of ground; the process equipment, with all of its auxiliary facilities is set on reasonably level ground with only a moderate slope for surface drainage purposes. The product storage, the railroad shipping facilities, leading plant and product pump station are set on a second level which is approximately 15 feet below the plant level. This has a distinct advantage in case of a storage tank fire, eliminating any possible hazard to the plant.

The process vessels and other equipment are arranged around a three-deck steel structure. The lower part of the structure forms a building which houses all of the process pumps, propane refrigeration compressor unit and the main instrument control panels. The roof of this pump building is a reinforced concrete slab which provides an operating deck around all of the reflux accumulators, these vessels are elevated to provide the necessary NPSH for process pumps. On the top deck of this structure are installed all of the vapor condensers from the fractionating columns and stills, together with the propane condensers on the discharge of the refrigeration compressor. This deck is covered with a checkered floor plate providing an operating platform around all equipment. A continuous monorail is provided for removal of tube bundles.

Refrigeration capacity using propane, is installed to chill the high-pressure wet gas, lean oil and deethanizer overhead to approximately 60° F. By employing a centrifugal compressor with a turbine drive, considerable flexibility can be obtained by speed variations. The unit selected is capable of producing 1400 hp. of refrigeration at a speed of 7600 rpm. A feature in the use of this type of machine is the compactness, resulting in a comparatively small foundation and operating space requirement. The unit is installed in the process pump building with its steam condensing equipment located directly overhead on the second deck of the distillation structure.

The propane system is quite conventional. All chillers are of the kettle type with U tube bundles for handling the process fluid. Propane vapors leaving the chillers are controlled by individual back pressure regulators allowing each unit to be carried at its optimum temperature. Vapors are returned directly to the compressor and discharged to water cooled condensers. Liquid propane at 105° F. accumulates in a surge drum and is then flashed in an economizer to 60° F. Vapors from this flash pass to the second wheel of the centrifugal compressor, resulting in a 5 to 10 percent saving in horsepower requirements. The chilled liquid propane is returned to the chillers, completing the cycle.

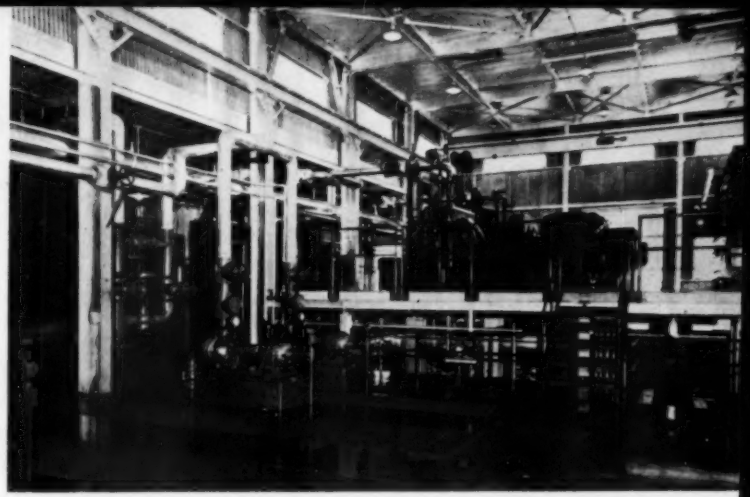
The use of refrigerated light oil with low vent gas pickup in the main absorbers results in a greatly reduced recompressor load from that which is normally experienced of plants using previous conventional designs for high propane recovery. Two separate recompressing services are required by this process, the first to handle excess reabsorber residue vapors above plant fuel requirements, compressed to the sales gas system. The second duty consists of the high-pressure flash gas which is recycled directly to the main absorbers.

Two 400-hp., angle-type, gas engine driven compressor units were selected to perform the recompressor duties. Each unit is provided with cylinders for the separate services in order to provide flexibility caused by failure of one unit. These units are located in a building set apart from the process area. Lines carrying vapor to and from the recompressors are anchored on concrete piers above ground. To shorten and simplify piping and provide for ease of operation, gas interstage coolers, scrubbers, accumulators and auxiliary equipment such as jacket and lube oil coolers are located adjacent to the recompressor building.

The plant electric power is generated by two 700 KW condensing type Turbo generators. Each unit consists of a high speed condensing type turbine operating at 8800 rpm., connected by a gear reducer to a 700-kw., 80 percent power factor, 3-phase, 60-cycle, 480-volt, 1200-rpm. generator. Normally one of the units operates while the second is for standby duty.

The switchboard is of the fully enclosed type with switch gear for the main generators and safety switches for all the plant equipment. Dual feeders extend from the switchboard to the various distribution centers in the plant. In the event of failure, by operation of a master switch any one of the main circuits can be isolated. Starters for all the process pumps and shipping pumps are located on outside racks adjacent to the equipment they serve, with push button stations at each pump. The starters for the cooling water pumps and tower fans, which are the largest single loads in the plant, are located in a small building near the cooling tower. All equipment is installed to conform with the electrical code for hazardous areas.

A feature of the steam plant, which has resulted in an unusually good steam balance for the entire plant, consists of three distinct steam systems operating at 350, 160 and 50 pounds. The 350-pound steam is generated in three 60,000 pounds-per-hour steam generators of the water tube boiler type. This high-pressure steam is used for all turbine drives, as well as the high-temperature level heating. Exhaust pressures for the turbine drives are so arranged to provide for all the low temperature level heating steam and all stripping steam requirements at either the 160 or 50-pound level. To maintain balance each header makes up or relieves into the lower header with the excess 50-pound steam relieving into an air cooled fan type unit. The actual load for this condenser represents largely the evaporator load for the boiler plant makeup as 50-pound steam evaporates the raw makeup water.



Turbo generators and auxiliary steam plant equipment is shown in this interior picture of the power plant building at Dubach, La.

Since fired heaters were eliminated entirely from the plant, a considerable portion of the steam load is for high-temperature heating. All 350 - pound condensate is gathered in an accumulating tank and flashed to 200 pounds. The flashed steam vapors at 200 pounds are used to drive a vertical pump returning this 200-pound condensate directly to the boilers. The advantages of the steam heating over fired heaters for high - pressure absorption plants can be obtained with the relatively low maximum temperature required. Not only is another operating area and special safety equipment eliminated, but simplicity of control results in far less operating difficulties.

The plant water supply is furnished from two wells producing from a sand approximately 500 feet deep. This water is remarkably soft, requiring no treatment for use in shell and tube cooler and condensers except chlorination for algae control. Raw water makeup to the boilers is treated to remove carbon dioxide and oxygen, and then passed through an evaporator. In order to reduce the circulating cooling water load, a dual system is installed. The 85° F. water from the tower passes through the units requiring minimum operating temperatures, discharges at 95° F., and then passes through the balance of the units where minimum process temperatures of 115° F. or higher are sufficient. Pressure-controlled butterfly valves are installed to

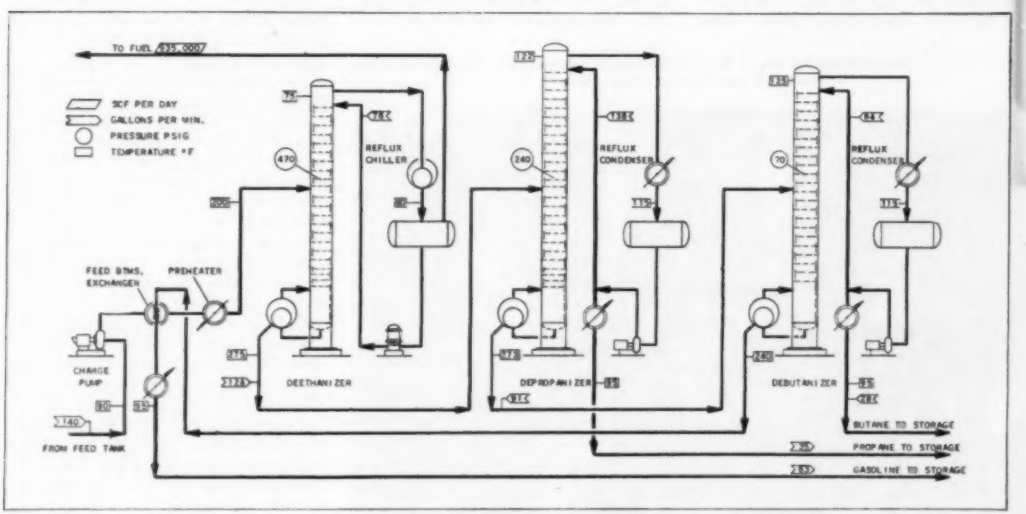


Figure 3. Process Flow Fractionating Light Ends.

Stills, oil exchangers and oil chillers shown in foreground of the above photo taken at the Dubach, La., gasoline plant. In the background may be seen the distillation structure, reabsorbers and high-pressure absorbers.

maintain sufficient water in the 95° F. system and also to balance water flow through the units located on the top deck of the distillation structure with those operating on ground level. This serves to maintain the required flow through all coolers and prevents the units located at the higher elevation from being robbed of cooling water.

The product storage farm includes twenty-four 1000-barrel, horizontal pressure tanks for butane, propane, LPG, and natural gasoline storage. Two 10,000 and two 20,000-barrel atmospheric type cone roof storage tanks are installed for motor fuel, these latter tanks being used for run-down and rolling during the lead blending process, as well as storage for the finished motor fuel product. Four 5000-barrel storage tanks for kerosine and gas oil are also of the cone roof atmospheric type. These tanks are equipped with flame arrestors, ground gauging devices, vents and foam nozzles. The actual foam piping has not been installed but is under consideration for future installation.

The plant shipping facilities include two spur tracks with a 22-car loading rack equipped for loading all products. A 2-island truck loading dock is equipped to load liquefied petroleum products, handling four transport trucks at one time. A gas-engine-driven reciprocating-type product pump has been installed which will handle gas oil, kerosine or motor fuel. This pump operates at approximately 950 psi. discharge and has a capacity of 150 gpm.

By installation of vertical type shipping pumps, complete elimination of a conventional pump pit has been accomplished. This type of pump has the net positive suction head built into it by submergence of the bell or lower portion of the pump in a casing below the floor or operating slab. All of the pumps are installed outside with only a small operator's building provided which permits him to make out his necessary shipping reports out of the weather. Also included in this small building is the dye pot for coloring the motor fuel.

The lead blending plant is of the conventional type used widely on all gasoline plants of this type; it includes an 8500-gallon lead storage tank with scales, educator pumps, unloading facilities and other standard equipment which is usually specified by the companies which specialize in furnishing this type of installation.

Protection from fire has been provided by the installation of two gas engine driven centrifugal pumps with a capacity of 150 gpm, when discharging at 200 psi. Fire hydrants have been installed near all of the major buildings and equipment throughout the plant, with two hose carts located at points in the plant where they can be conveniently operated if the need occurs. CO_2 gas extinguishers, the hand size and larger push cart type, are provided at convenient locations throughout the plant. Steam connections have been installed at numerous locations in the process area where, in cases of emergency, steam hoses could be readily attached and used for smothering a fire.

The Fish Engineering Corporation of Houston designed, engineered and constructed the complete plant under inspection and approval by engineers of Southwest Gas Producing Company.

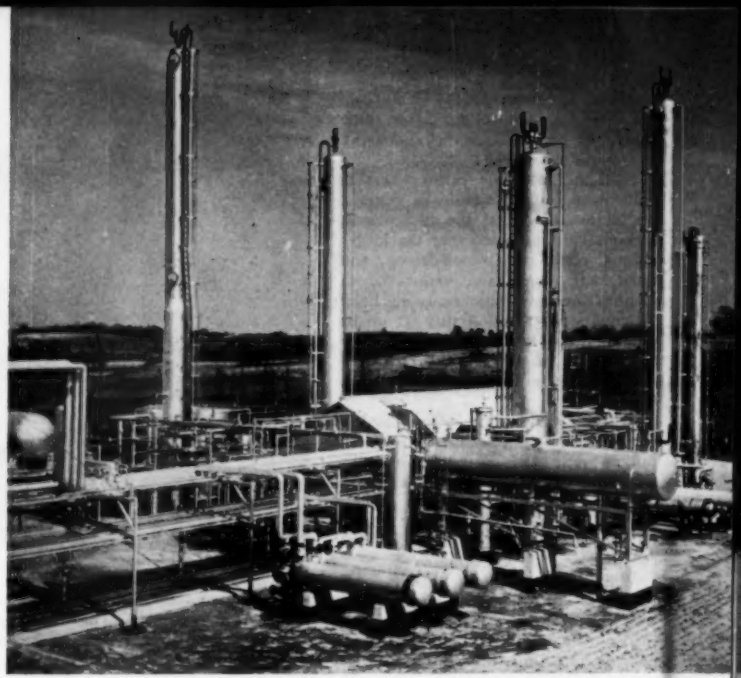
Patent application has been made by Superior Oil Company for the process employed in the design of this plant. The construction rights have been assigned to The Fish Engineering Corporation.

Partial View of Process Pump Building at the Southwest-Feazel Gasoline Plant. Fractionating plant instrument board may be seen at the left.

MORE THAN 60 percent of the equipment used in the building of the two plants, Lisbon and Harleton, was taken from the Long Lake plant. As a result, the plants were in operation much earlier than would have been possible if all the equipment had been purchased new, due to uncertain delivery dates of the new materials.

Economic utilization of the existing equipment in the new plants required considerable study, especially in the case of the fractionating columns. For example, the cost of installing an existing tower, perhaps slightly oversized, for a certain service was compared with purchase of a new column and use of the existing tower in a third alternate scheme.

Actual operation of the plants have resulted in somewhat higher recoveries than anticipated.



Processing Area of Hunt Oil Company's Harleton, Texas Plant. Left to right may be seen: the contactor-reabsorber, absorber, still debutanizer and deethanizer.

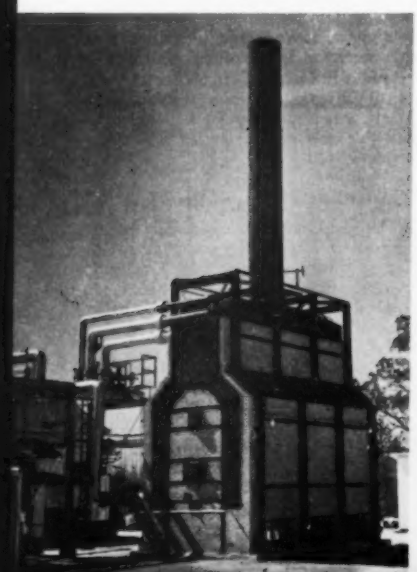
Two Absorption Plants Use Existing Equipment from Third

JAMES STOPFORD

Delta Engineering Corporation, Houston

EARLY in 1947 Hunt Oil Company completed certain economic studies concerning its reserves in the Northeast Lisbon field of Union Parish, Louisiana, which indicated an adequate reserve of sufficiently rich gas to warrant a plant installation. Concurrent studies pertaining to the Harleton gas field in Harrison County, Texas, had resulted in a similar conclusion.

Photo below shows the rich oil heater in Hunt Oil Company's plant at Lisbon, La.



Meanwhile, a recycling plant operated by Hunt at Long Lake near Palestine, Texas, had just about reached its final economic depletion point. With these facts in hand, Hunt Oil Company called in an engineering organization to make a study of possible plant installations in the two fields making maximum usage of equipment in use at the Long Lake plant.

Since material deliveries were very poor at that time, particularly on high-pressure equipment, it was felt that a considerable saving of time as well as money could be made by utilizing the Long Lake items. It was particularly fortunate that two high-pressure absorbers and two high-pressure lean oil pumps were available which would permit an installation at each of the two proposed new sites. Such an installation would permit approximately 100 percent capacity operation at Harleton and would permit operation at about 50 percent capacity at Lisbon until a second absorber could be purchased new.

While the choice of one absorber for each of the two locations was obvious and simple, the judicious selection of the fractionators and flash vessels available for use at one or the other location required considerable study. With the service requirements available from process study, it was necessary to investigate alternate uses of each vessel. In the case of the fractionators, it was necessary to compare the cost of installing an existing vessel, possibly slightly oversized, for a certain service, versus buying a new column and using the existing vessel in still some third alternate scheme.

A similar series of possible equipment selections and modifications had to be effected in making suitable disposition of the heat transfer equipment, pumps, instruments, control valves, buildings, storage tanks, blend-

ing facilities, and so on. After some study, the pumps were distributed by two major catagories:

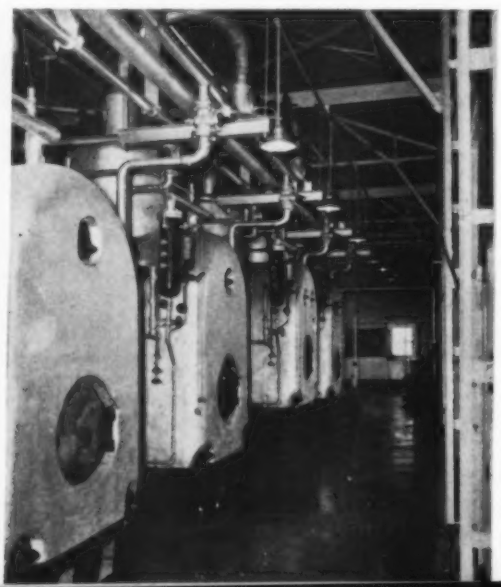
1) Some available turbo-generator units were found suitable in size for use at the larger of the two plants, Lisbon. This indicated that the larger pumps could be motor-driven and since both steam and motor driven pumps were available at Long Lake a primary distribution was set up of steam pumps to Harleton and motor to Lisbon. Of course, this was not rigid but permitted a basis of initial decision.

2) A second major basis of selection was by pump manufacturer. The pumps were made by about four different companies and it was ascertained that by separating by makes, the number of maintenance parts to be stocked at any particular location could be kept to a minimum.

While some of the selections were relatively simple, others, such as vessels, heat-transfer equipment, pumps, instruments, and control valves took considerable time and study in order to determine the optimum alternate. Such studies made the job of engineering the new plant considerably more difficult and time consuming than in the case of a plant with all new equipment in which case selection could be straight-forward and direct. However, utilization of the existing equipment more than made up for it in direct cost savings and in time saving by elimination of material delivery waits.

The Lisbon Plant

The plant at Lisbon is a conventional pipe-line absorption plant operating at an absorption level of approximately 1000 psig. with reabsorption at 100 psig. The recovery side of the plant makes use of a rich oil contactor consisting of six bubble trays built into the lower half of the reabsorber. The process step at that point consists of contacting the total rich oil stream at its lowest pressure level, counter-currently with the net gas from the still. During this contact, the relatively low methane content of the gas strips methane from the rich oil, displacing it with heavier components. In this way the rich oil stream acts as an absorption oil and reduces the reabsorption requirements considerably. Condensate and rich oil are carried through in separate channels to the raw feed to eliminate contamination of the lean oil with undesirable heavy materials and to reduce the still load.



At left is a view of the boiler house at the Hunt Oil Company's Harleton, Texas, plant.

By close examination of the flow sheet it will be seen that the condensate discharges into the raw feed tank at one end and the still overhead into the other. The vessel is separated into two sections by a weir which prevents contamination of the still reflux by heavier materials from the condensate entering the still through the reflux, while the net overhead overflows the weir into the bulk raw feed storage.

The stabilization side of the plant is quite complete and fractionation facilities are provided to produce pure propane, mixed butanes, vapor pressure gasoline, kerosine, mineral seal oil and residuum. No portion of this section of the plant is particularly unique although it might be noted that the distillate fractionator is a packed column, a move made to utilize an existing Long Lake column which appeared a little "tight" if used with the existing trays. All high temperature reboil heat is supplied by hot lean oil and live and exhaust steam are used where feasible.

Auxiliary Phases of the Plant

The gasoline produced is leaded and pumped into a nearby products pipe line by means of a gas engine driven triplex pump. All gasoline is dispatched in this manner while the balance of the products are removed by trucks, loaded from a 4-spot rack at the plant site or by tank cars from an extensive rack at Bernice, eight miles away. The truck loading pumps were selected to be used in either service; loading at the plant or through the eight miles of pipe line. The loading

General view, above and left (on opposite page), of the Lisbon, La., Plant of Hunt Oil Company. Much of the equipment in this plant, as well as the same company's Harleton, Texas plant, came from a third plant, it being utilized after considerable study of the economics involved.

rate in the latter service is a trifle slower than usual but has been adequate. Contact between the plant and the tank car loading rack is maintained by radio telephone which equipment is also used in the field for the dispatchers taking care of the wells feeding the plant.

The power plant consists of six oilfield type boilers, some of which were available from Long Lake and some made available from drilling rigs which had been modernized. Superheating is supplied by utilizing four tubes of the rich oil heater.

All condensate is returned and a deaerating feed water heater is used to keep down the oxygen content. A single water well supplies about 650 gpm. of water, a large portion of which is used on a once-through basis for cold water cooling on final condensers and coolers in critical services. An artificial lake receives the run-off and standby fire and water pumps have been installed at the lake to provide makeup water when necessary. The cooling tower is a three-cell induced draft unit with some sections mounted for contact by well water. Exhaust steam condensers are mounted in the basin adjacent to circulating pump suction.

A single 225-hp compressor is used to recover low-pressure gas in excess of the fuel requirements. Solid desiccant type driers are used to dry all the gas before it enters the pipe line.

Buildings include a combination office, warehouse, changehouse and a separate laboratory building. The high pressure lean oil pumps are motor driven triplex units and are housed in a building with the control instruments. An ethyl blending building, boilerhouse and recompressor house complete the structures.

Statistical Data

The plant has a nominal capacity of 50 million standard cubic feet daily and was designed for 30 percent recovery of propane and 80 percent recovery of butanes with essentially 100 percent recovery of all heavier materials. Design production rates were:

	Gallons/Day
Propane	8,500
Butanes	12,650
Gasoline	42,100
Kerosine	7,600
Mineral seal oil	2,050
Residuum	500
	73,400

Actual operations have resulted in somewhat higher recoveries. Steam consumption is approximately 35,000 pounds per hour, and is supplied at 250 psig. Approximately 350 kw. of power is supplied at 440 volts, 60 cycle, 3 phase for all services except some small pumps and spares which are steam driven. Storage for about seven days production has been provided with additional blending tanks available for gasoline service.

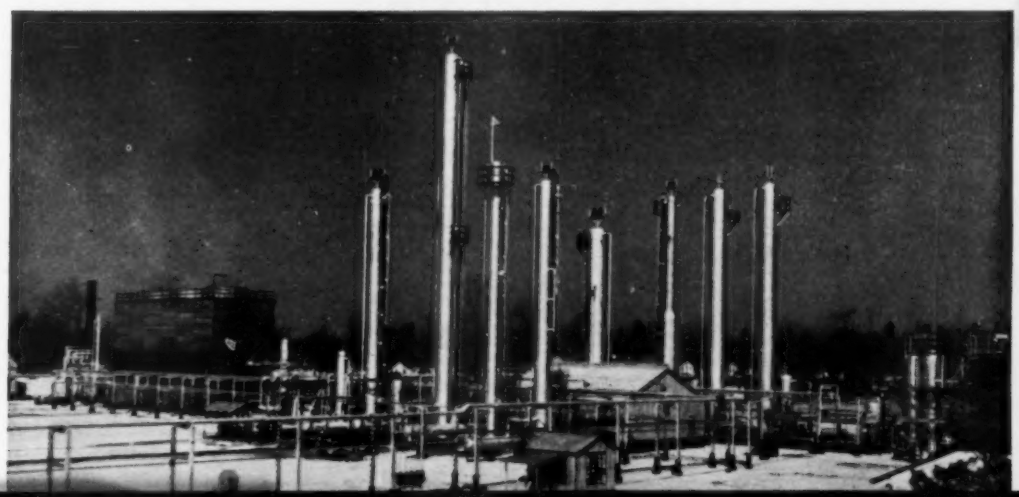
Conclusion

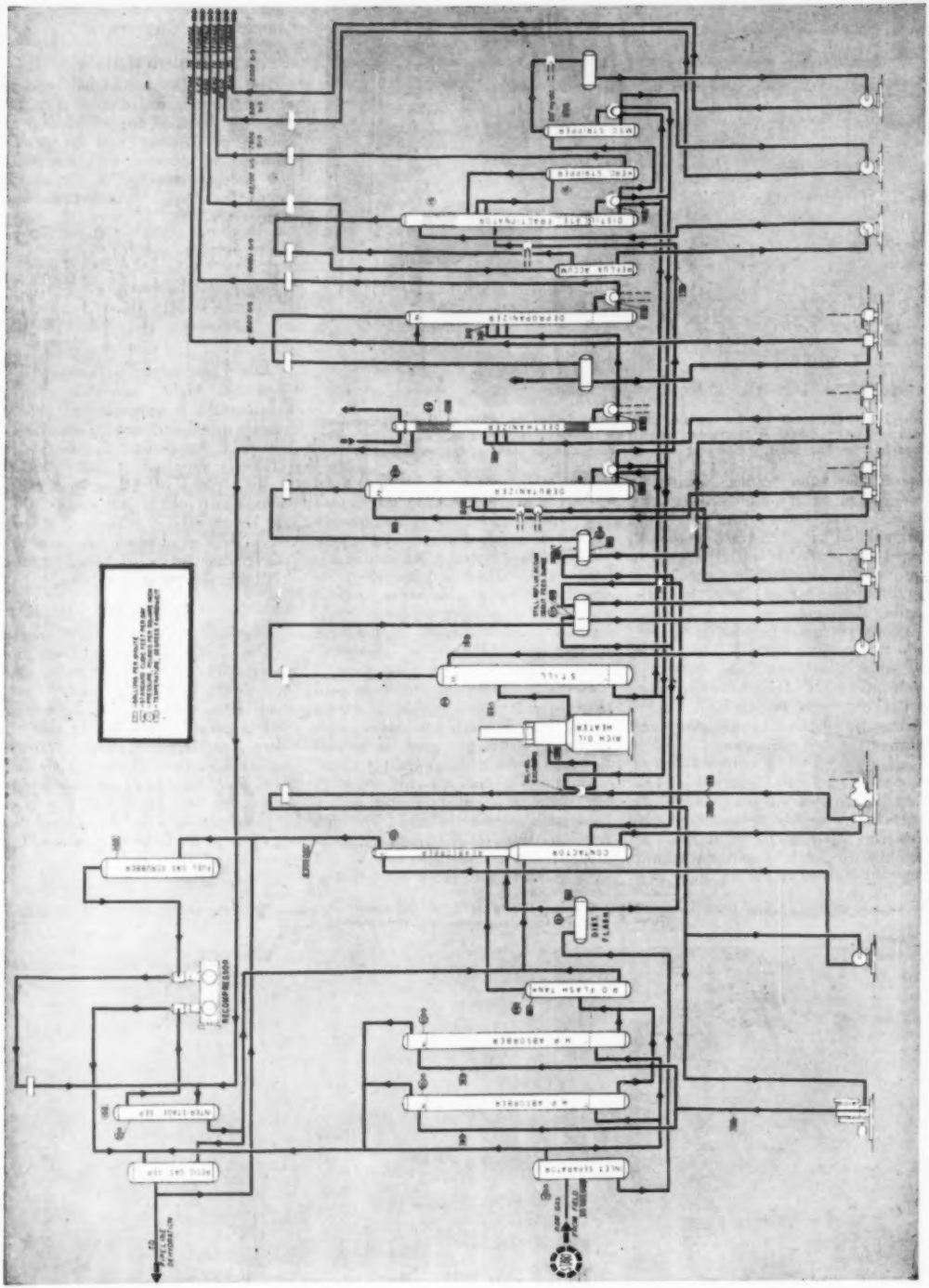
Considerably more than 60 percent of the plant's varied items from pipe, valves, fittings, to boilers, compressor and heavy walled pressure vessels came from the old Long Lake plant and is proving its worth in a second plant installation, having allowed earlier operations in the Lisbon field than could have been possible had all equipment been purchased new.

Both plants were engineered and constructed by Delta Engineering Corporation of Houston.

(See flow sheet, next page)

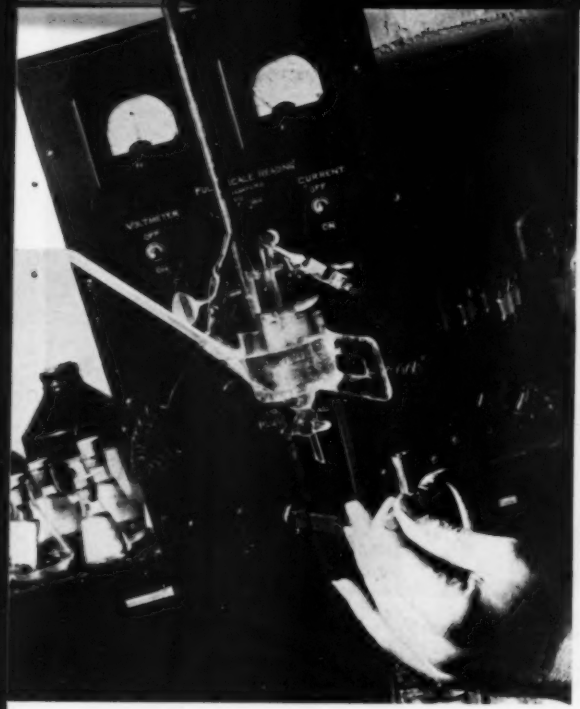
Process area of Hunt's Lisbon plant is shown below. Columns, left to right, are the distillate fractionator, depropanizer, deethanizer, debutanizer, still, contactor-reabsorber and two absorbers.





Flow Sheet of the Lisbon, La., of Hunt Oil Company. (See article on preceding three pages.)

Micro-Chemical Lab Does Fine Analyses For Oil Industry



WEIGHING THE PROBLEM—This technique helps the chemist to determine microscopic amounts of metallic contaminants in an oil. Above, he is preparing to weigh one millionth of a gram. To find and weight this metallic sludge, the petrochemist electroplates the metallic constituents onto a platinum electrode. Since the weight of the clean electrode is known, it becomes easy to determine the weight of contaminant.

AT THEIR BEACON, N. Y., research labs, Texaco scientists have found that they can separate as many as 100 different chemical compounds out of a single drop of oil. Employing pipettes smaller than a needle, drop-size beakers, and balances designed to weigh almost nothing, the entire "lab" could be packed into an undersized overnight bag.

This is Texaco's micro-chemical lab—employing techniques well known to crime detection and now adapted to find and analyze all sorts of costly and elusive chemicals and oils. Results: new discoveries; vast savings in time, money and effort; and finally, improved fuels and lubricants.

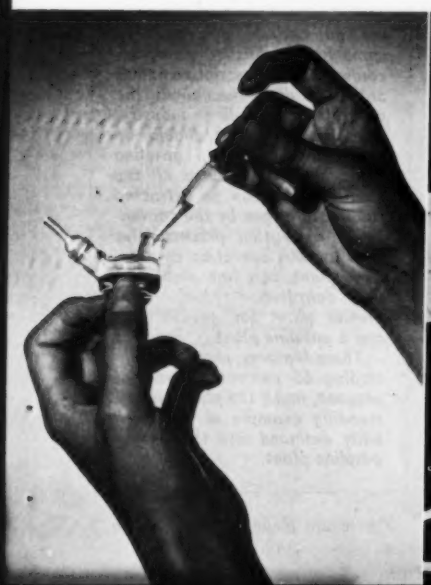
At a regular refinery, for instance, fractionators tower 10 to 12 stories in the air whereas in this laboratory a three-inch fractionating flask is used to produce the same or better results, qualitatively. The method: a minute sample of distilled oil is drawn into a pipette by capillary action and is sealed into the tip of a tiny tube to determine the all-important boiling range. The boiling point is the first clue to establishing the composition of a sample.

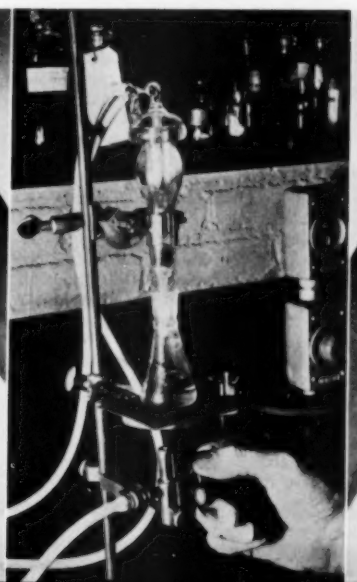
Other procedures employed by such laboratories are shown in The Texas Company pictures on this page.

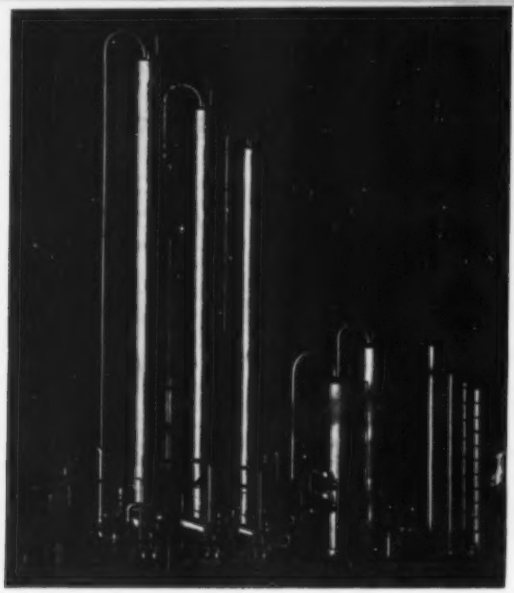
SLUDGE FILTER—Hand on right is placing a "precipitating reagent"—a chemical that removes the metals from the solution to the bottom where they can be collected—into a sample of oil. Porous glass filter in the arm on the left of the beaker permits withdrawal of liquid after the precipitation has taken place. Beaker holds two or three drops.

MICRO - EXTRACTION — This technique permits the chemist to determine how much of what is to be found in any given piston deposit. After this analysis is made, he can identify the type of dirt or varnish on the piston and determine how much it weighs. Once this is known, the oil composition can be changed and improved as required.

NEEDS EASILY MET — This drop-sized beaker holds less than one fourth a teaspoonful—more than enough for the micro-chemists' needs—and the miniature pipette holds all of half a drop.







Process pumps, except the lean oil pumps, are in the Silsbee gasoline plant pump house at the left. The columns, left to right, are the butanizer, depropanizer, deethanizer, evaporator, still, reabsorber, 600-psi. absorber, 900-psi. absorber, and 2000-psi. absorber. Absorption oil heat exchangers are between the still and reabsorber. The boiler house is at the end of the row of columns.

"Combination Gasoline Plant" Goes on Stream at Silsbee

W. T. BRYANT

General Superintendent, Gas-Gasoline Department,
American Republics Corporation, Houston

A NEW "combination" gasoline plant, designed to extract 125,000 gallons daily of liquid hydrocarbons from 60 million cubic feet daily of natural gas, inject high-pressure gas for cycling, supply processed and dehydrated gas to a transmission pipe line, and supply gas for gas-lift operations, was recently placed in operation by American Republics Corporation, Houston. Location of the plant is the Silsbee field of Hardin County, about 25 miles north of Beaumont.

The plant processes the 2000-psi. gas for cycling as the result of unitization of the field. The companies participating in the unitization of the field are American Republics Corporation, Houston Oil Company, Humble Oil & Refining Company, and General Crude Oil Company. As part of the agreement, the plant was erected and will be operated by American Republics Corporation. The low-pressure oil-well gas is processed on the basis of a pooling agreement. This gas is compressed to 900 psi., processed and dehydrated, and sold to Texas Eastern Transmission Corporation. The plant effects conservation of the gas and liquid hydrocarbons and eliminates flares.

Engineering design and construction of the new plant was by Gasoline Plant Construction Corporation, Houston.

The total production of the plant of 125,000 gallons daily of liquid hydrocarbons, includes 30,000 gallons of propane (65 percent recovery); 30,000 gallons of butane; 60,000 gallons of motor fuel, and 5000 gallons of kerosine and gas oil. In addition, the plant produces absorption oil, naphtha, LPG, and a distillate product.

Inlet Gas

Gas enters the plant at 35, 150, 300, 600, 900, and 2000 psi. for contacting with absorption oil in three towers operating at 2000, 900, and 600 psi. These inlet pressures somewhat complicated the design of the process in view of the fact that the field gas at 2000 psi. was to be injected at about 4000 psi., sales gas had to be delivered at 900 psi., gas-lift gas at 600, and compressor horsepower had to be held to a minimum. Since the 35 cubic feet of gas at the wellhead pressure of 2000 psi was to be injected, a single high pressure absorber is used to contact this volume of gas with absorption oil. The compressor horsepower required for field injection was reduced by absorbing at 2000 psi. instead of at a lower pressure. Total compressor horsepower required for the plant is 3200. The residue gas is

THE TERM "gasoline plant" is not an entirely appropriate name for the Silsbee plant, according to the descriptive names ordinarily used throughout the natural gas-gasoline industry. Actually, the plant should be called a combination gasoline plant, since it produces all the products that can be extracted from natural gas by the conventional absorption process, plus simultaneous operation as a cycling plant, pipe line absorption and dehydration plant, compressor plant for gas-lift gas, and a gasoline plant.

These features, plus others including 65 percent recovery of propane, make the plant an outstanding example of the flexibility designed into the modern gasoline plant.

Gasoline plant operated by American Republics Corporation in the Silsbee field, Hardin County, 25 miles north of Beaumont, Texas. From left to right, starting on page opposite, are shown storage tanks, compressor building, cooling tower, process pump house, and the deethanizer, depropanizer, and debutanizer columns. Stacks of the six, 150-horsepower, 300 psi., oil-field type boilers are in the background.

compressed to approximately 4000 psi. and returned to the field for injection. This high-pressure absorber is unusual in that it is a single forging, measuring 46 feet from seam to seam. It is 60 inches in diameter with 3⅞-inch walls and 3-21/32-inch heads.

Three of the remaining gas streams —35, 150, and 300 psi.—are compressed to 900 psi., combined with the 900-psi. stream of field gas, and contacted in the 900-psi. absorber. Residue gas from this absorber is dehydrated and delivered to a sales gas transmission pipeline at 900 psi. It should be noted on the flow diagram that the inlet scrubbers, for 35, 150, and 300 psi. gas, also serve as interstage knockout drums for the compressors. The 4 million cubic feet of gas entering the plant at 600 psi. is contacted in the 600-psi. absorber. This gas is received by the plant from compressor station in the field, which, previous to construction of the plant, had been used for gas-lift gas compression. Residue gas from this absorber is piped to the field for gas lift use.

An analysis of the inlet gas to the Silsbee plant is given in Table 1. The molecular weight of the absorption oil used in all the absorbers of the plant is about 200.

As shown on the flow diagram, the rich oil from the high-pressure 2000-psi. absorber is flashed to the base of

TABLE 1
Analysis of Inlet Gas, Silsbee Plant

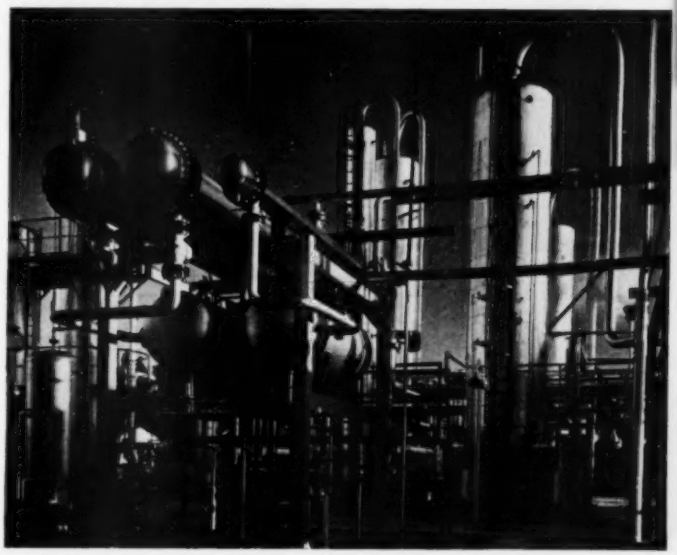
	Combined Streams—35, 150 and 300 psi. Mol. percent	Combined Streams—900 and 2000 psi. Mol. percent
C_1	87.76	86.64
C_2	6.00	5.94
C_3	3.21	3.08
iC_4	0.77	0.79
C_4	1.06	0.96
iC_5	0.26	0.38
C_5	0.50	0.37
C_6+	0.44	1.84
	100.00	100.00

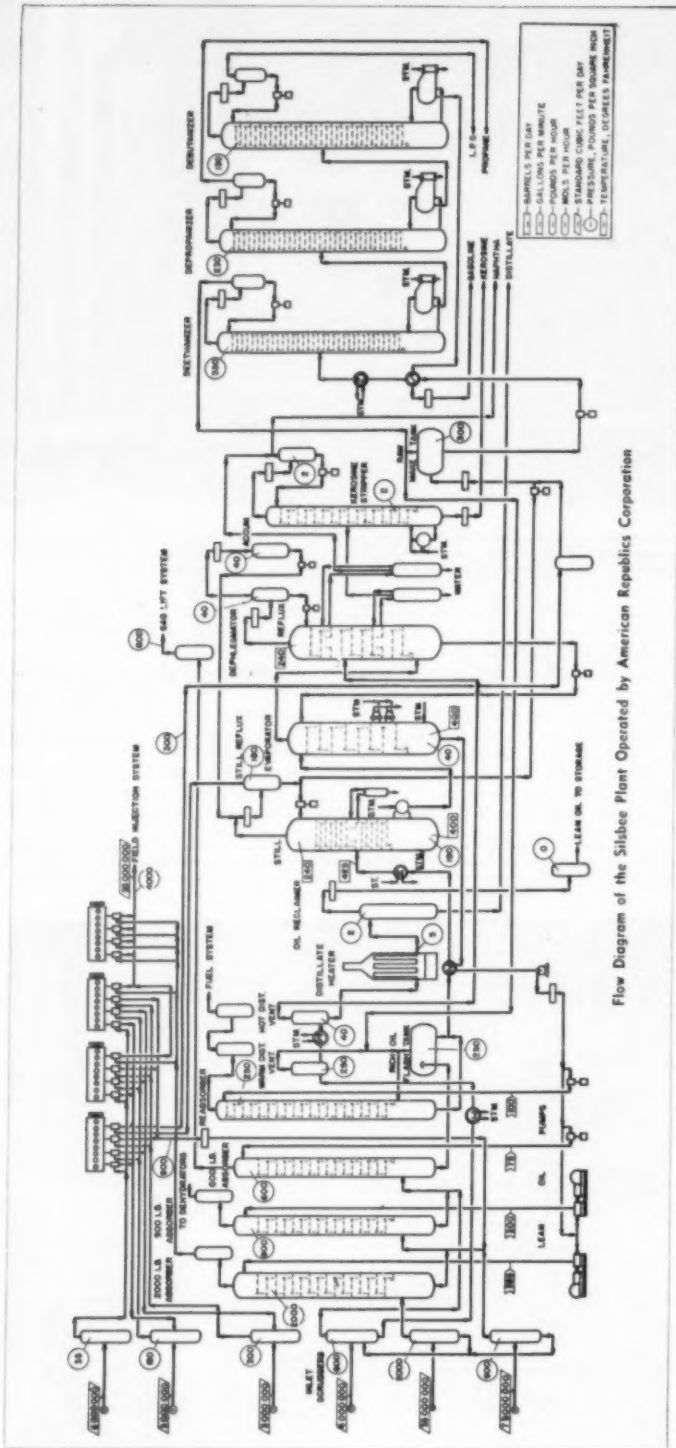
Table 2 shows an analysis of the residue gas from the 2000-psi. absorber as determined recently by actual tests.

TABLE 2
Analysis of Residue Gas from 2000-psi. Absorber
Sp. gr. at 60°/14.696 psia. (air = 1) = 0.5873

	Mol. percent	GPM
Carbon dioxide	0.40	...
Nitrogen	1.20	...
Methane	94.22	...
Ethane	3.67	
Propane	0.48	0.132
Butane	0.01	0.003
Hexane +	0.02	0.008
	100.00	0.143

Condensers and reflux accumulators for the deethanizer and oil reclaimer. The still is to the left of the evaporator, which is in the row of columns. Rich oil stripped of uncondensibles flows from the bottom of the still to the top of the evaporator. Vapor to the recompressor is supplied at a higher pressure, than if a single low-pressure still had been used.





Flow Diagram of the Silsbee Plant Operated by American Republics Corporation

the 900-psi. absorber, then the combined rich oil streams from both absorbers is flashed in the 600-psi. absorber. This system serves to combine the three rich oil streams, eliminates separate flash tanks, and effects a primary demethanization of the rich oil.

The gas overhead from the 600-psi. absorber is returned to the field for gas-lift operations. Total combined rich oil from the low-pressure absorber is then flashed in the rich oil flash tank. Flashed vapor from the tank flows to the reabsorber along with gas from the cold distillate vent tank and raw make tank vapor for the recovery of propanes and heavier. The rich oil from the reabsorber is combined with the rich oil from the flash tank, then the stream flows through the absorption oil heat exchangers, through a steam preheater to the still.

Still, Evaporator, and Dephlegmator

The first separation of absorbed hydrocarbons and absorption oil is made in the still. Uncondensed vapors flow overhead from the still, and the remaining hydrocarbons in the rich oil that are totally condensible, are charged to the top of the evaporator. It should be noted that the still, evaporator, and dephlegmator are installed as three separate towers, although they perform the functions of two towers—high and low-pressure stills. By having the evaporator and dephlegmator in separate towers, the draw-off of condensed steam is facilitated, and the draw-off trays for naphtha and kerosine are low enough that their operation can be checked by gauge glasses, which can be read by the operator from ground level. Also vapor to the recompressor is supplied at a higher pressure, than if a single low pressure still had been used.

Final separation of the absorption oil and absorbed hydrocarbons is made in the evaporator and the lean oil returned to the absorbers from the bottom of the tower. The hydrocarbons stripped from the oil go overhead to the dephlegmator for a primary separation. One of the features of this installation is that absorption oil carried over from the evaporator is pumped back from the bottom of the dephlegmator and recovered.

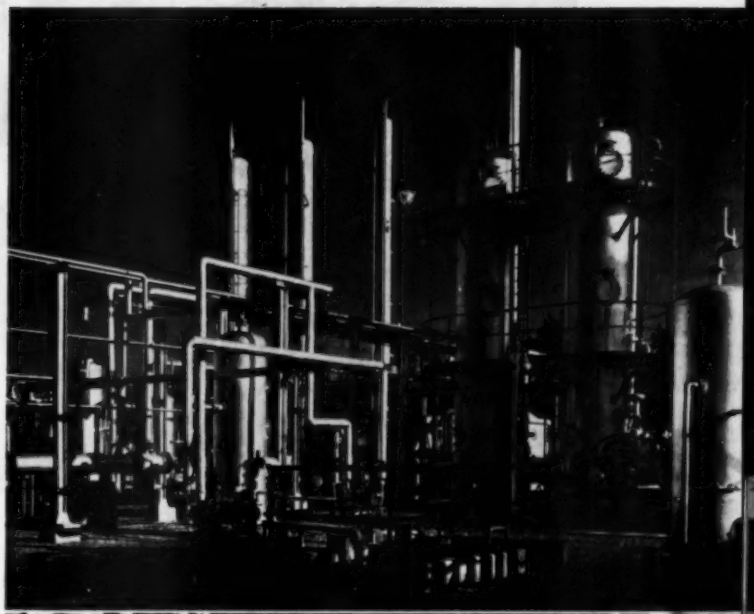
In addition to the vapor charged from the evaporator to the dephlegmator, raw distillate vapor from the hot distillate vent tank is charged to the tower at a lower tray than the evaporator vapor. Two draw-off trays remove naphtha and kerosine, which is split in a kerosine stripper tower.

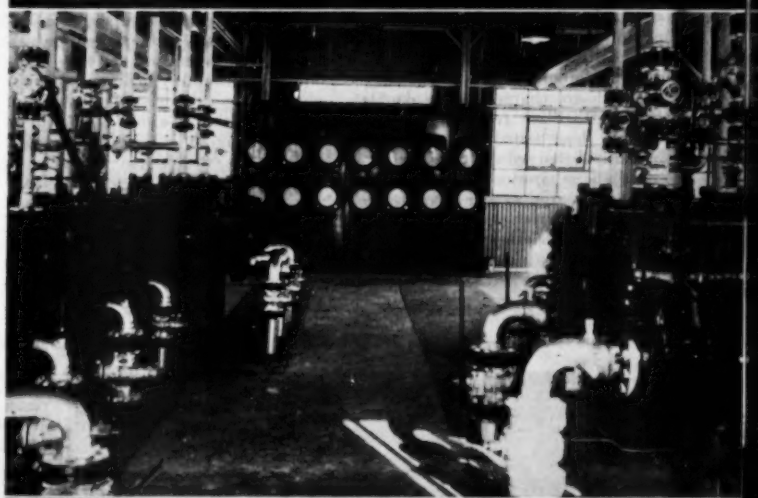
From the dephlegmator, propanes, butanes, and gasoline vapors flow

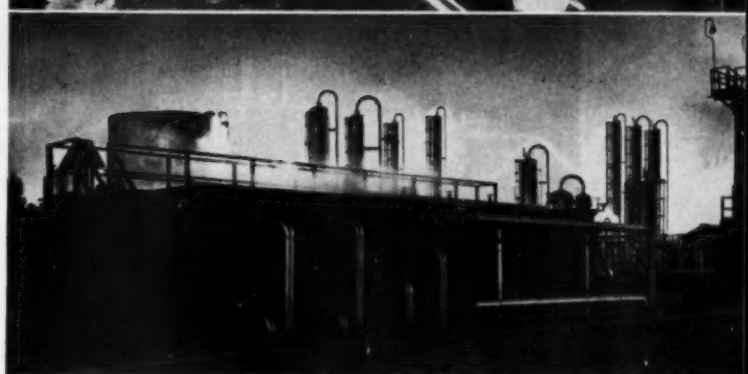
Top photo—Residue gas from the 900-psi. absorber is dehydrated before delivery to the gas transmission pipe line. The dehydration unit is of conventional design employing bauxite as the desiccant. When one of the two columns (shown above with the single platform) is on dehydration stream, the other is on the regeneration portion of the cycle. The cold distillate vent tank and the hot distillate vent tank preheater are at the left of the picture.

Center photo—Pump house of the plant contains all process pumps of the plant except the lean oil pumps. The instrument panel at the end of the building contains the instruments used in conjunction with the pumps.

Bottom photo—This coil shed is used for the compressor's engine jacket water and interstage cooling.



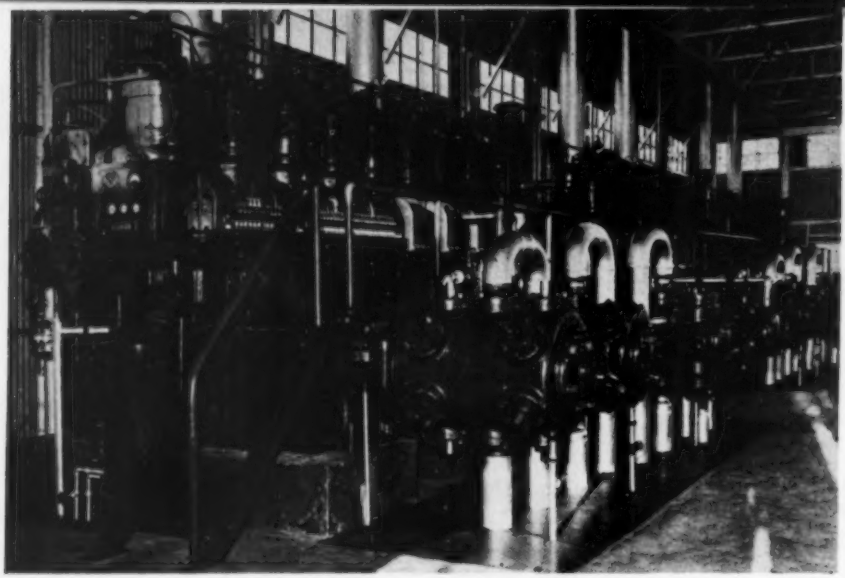




overhead from the tower through a condenser, which condenses sufficient vapor to supply the tower with reflux. The condensed vapors from the reflux drum are fully cooled and the liquid pumped into the line carrying vapor overhead from the still. Contacting these vapors with liquid utilizes both the cooling effect and absorptive ability of the liquid to remove liquefiable hydrocarbons from the vapor. This method is often referred to as the "one-tray" effect. It serves to reduce both cooling load and recompressor horsepower. These combined streams are cooled further in a condenser and flow into the reflux accumulator of the still. A portion of the resulting liquids in this drum are refluxed to the still and the remainder of the liquid and vapor from the accumulator are recombined in the line—after the vapor has been recompressed. After further cooling the stream flows to the raw make tank. Thus, the cooling and absorptive effect of the liquid on the uncondensed vapors is employed a second time. The pressure of the raw make tank is high enough that uncondensed vapors flow from the raw make tank to be combined with vapor from the deethanizer reflux drum, rich oil flash tank, and cold distillate vent tank and contacted with lean oil in the reabsorber.

Distillate Processing

Gas at 2000 psi. from the wells in the field does not flow through separators in the field; instead the 2000-psi. inlet separator at the plant is used for the combined streams. The resulting large volume of distillate from the inlet separator required installation of a separate distillate processing system. Distillate from the separator is flashed in three stages, to eliminate excessive cooling which would prevent effective flashing. The distillate from the 2000 and 900-psi. inlet scrubbers is first flashed in the 600-psi. inlet scrubber. Then the distillate goes through a preheater and flashes in a



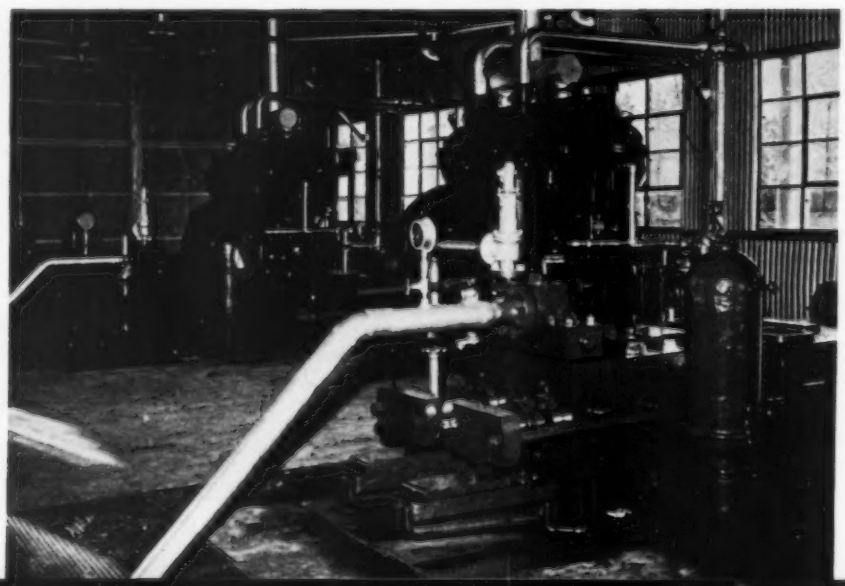
Three of the four, 800-horsepower, angle type, gas-engine- driven compressor that make up the 3200-horsepower used in the plant.

warm distillate vent tank at 250 psi. The remaining distillate passes through a second preheater and is flashed at 40 psi. in a hot distillate vent tank. Vapors from the warm flash flow to the reabsorber and vapors from the hot flash are charged to the dephlegmator. Distillate from the hot vent tank is then heated in a direct-fired heater and charged to the oil reclaimer tower for separation into distillate as the bottom product and absorption oil as overhead product.

The fractionating section of the plant was designed along conventional lines. It utilizes a deethanizer, operated at 500 psi., and a depropanizer and debutanizer, operating at 230 and 130 psi., respectively.

The compressors at Silsbee are 800-horsepower, two-cycle, angle-type, gas-engine driven. Each of the four units, which are installed in line, have four compression cylinders. Manifolding of the compressors, which is shown on the flow diagram is somewhat unusual. All of the compression cylinders on one engine are used to compress 2000-psi. gas to 4000-psi. for field injection. In addition, one cylinder on each of two other compressors is used for injection service. One cylinder on each of the remaining three compressors boosts the inlet 35-psi. gas to 150 psi., which flows to the 150-psi. inlet separators. This separator serves as the interstage scrubber as well as the inlet separator. Gas from the 150-psi. separator is then compressed in one cylinder on each of the same three compressors from 150 to 300 psi., then discharged to the 300-psi. inlet separator for interstage scrubbing. From the 300-psi. separator, gas is compressed in one cylinder on each of the compressors to 900-psi. and charged to the 900-psi. absorber. Duty of the remaining cylinder is compression of vapor (175 to 300 psi.) from the still for charging to the raw make tank.

Three pumps supply the 2000-psi. absorber and 900-psi. absorber with absorption oil. The third pump serves as a standby.



***THE CHOICE** of voltages for process equipment drivers is often made in rather arbitrary fashion on the basis of existing practice at the plant involved. The over-all economics involved in the choice may not be investigated. It is often difficult to side-step precedence. A careful analysis of the many factors of initial cost, operational economies, maintenance expenses, personnel skill, and reliability considerations, however, will either confirm a "choice by precedent" or will develop sound reasons for variation.*

In this thorough article the author outlines both theoretical and practical advantages and disadvantages encountered with the voltages in common use in the process plants. Conclusions are given which should prove useful to the operators of such equipment.

The Economics of Motor Voltage Selection

PART I

E. T. HORRIDGE
Electrical Engineer, Utilities Department, Houston Refinery
Shell Oil Company, Inc.

THE economics of motor voltage selection involves consideration of many factors beginning with the power distribution system and concluding with an evaluation of the reliability of the completed motor installation. It, perhaps, is unnecessary to say that the most economical motor voltage would involve more than consideration of the lowest initial equipment cost. It would in addition be concerned with minimizing maintenance and would insure the highest degree of reliability consistent with the requirements of the specific installation. In short, the most economical voltage infers the lowest overall cost after all factors have been evaluated.

Motor installations must in every case bear a proportion of the cost of the generating and distribution systems. The fact that motors of equal horsepower rating, irrespective of voltage characteristics, burden generating and distribution facilities alike does not eliminate consideration of these facilities when comparing the installation costs of motors of different voltages. Distribution voltages once established particularly affect the selection of the most economical voltage for large motors. A corollary of this fact is also evident, namely, that the effect of an established motor voltage is to directly influence the choice of the system distribution voltage. Consequently, the generation and distribution system voltages should be chosen so that the natural choice of motor voltages will result in general over-all economies.

Primary distribution voltages usually found in industrial plants which cover an appreciable area are 2400 volts, 4160 volts, and 13800 volts. The voltage used is a function primarily of load density and individual motor ratings, when factors such as precedence and special considerations can be waived. That precedence cannot be completely side-stepped has been effectively expressed as follows: *Selection of voltages for motors in oil refineries and similar industrial plants is commonly determined in accordance with rules and practices established for a number of years and not on the basis of economy as affected by the latest developments in the arts and with consideration to supply system requirements.* ("Motor Voltage Considerations in Oil Refineries," by E. Kun, PETROLEUM REFINER, February, 1946.)

The economic effects of power distribution system voltages as reflected in the ultimate cost of a motor installation is, as previously stated, partially a matter of system maintenance and operational economics. In addition, distribution system voltages directly affect the cost of motors, motor control, etc. Of special importance is the extent of the short circuit duty considered as a function of the voltage of the specific distribution system. The heavy currents coincidental with low-voltage distribution require momentary current ratings of protective equipment that substantially affect their costs, whereas the mechanical strains imposed upon equipment by high voltages results in expensive features of equipment design.

As already intimated, it is usually the direct motor, motor control, low-voltage substation and power cable costs which conclusively determine in the majority of cases the most economical motor voltage. Tabulations of these costs are included herein for reference when analyzing the costs of specific motor installations. Within the usual horsepower range, the cost of motors of a particular size increases as the motor voltage is increased. Motor control prices increase in most instances with the horsepower, with the voltage and with the interrupting capacity required, the last two factors being dependent on the characteristics of the distribution system.

No study of motor installation costs would be complete if an effort were not made to anticipate maintenance expenses. On the one hand the heavy currents associated with low voltages create a maintenance problem, whereas, on the other hand the high insulation values required, the greater degree of skill and supervision involved and the greater hazard associated with high voltages are reflected in maintenance costs. The maintenance of electrical equipment is in general more tedious and costly as the voltage is increased.

Reliability Most Important

So far only the tangible costs of a motor installation have been mentioned. There is, however, the question of reliability which is generally the most important consideration to every operator. A motor failure can easily "upset the applecart" and result in heavy losses to production. How important this factor may be depends upon the requirements of the particular installation being considered.

From the foregoing it is evident that the choice of the most economical motor voltage is not entirely concerned with motor and motor control equipment costs. Instead, the economics of motor voltage selection originates with and is thereafter compromised by the choice of a distribution system voltage; is concerned with the direct equipment and installation costs of motor and control; is concerned with achieving minimum maintenance costs; and finally must evaluate the intangible factor of reliability.

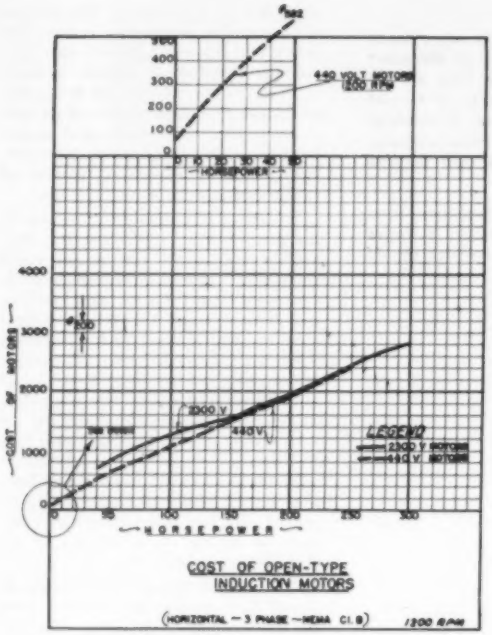


FIGURE 1

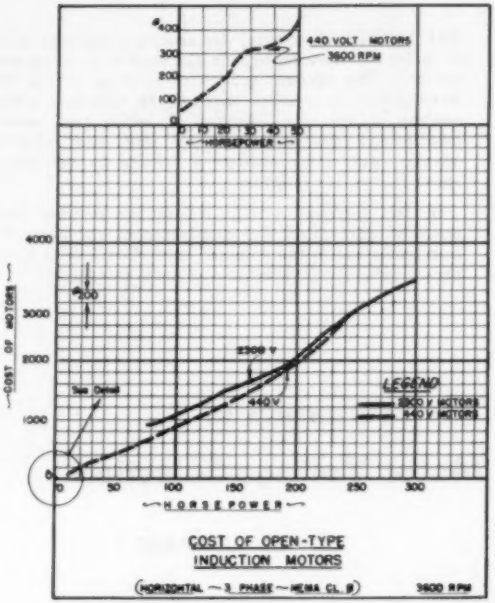


FIGURE 3

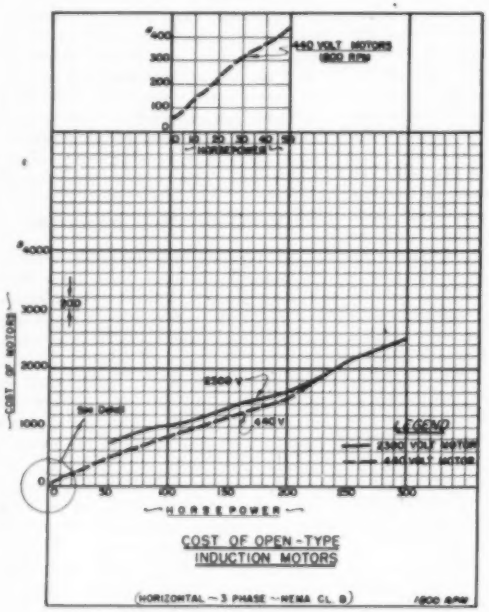


FIGURE 2

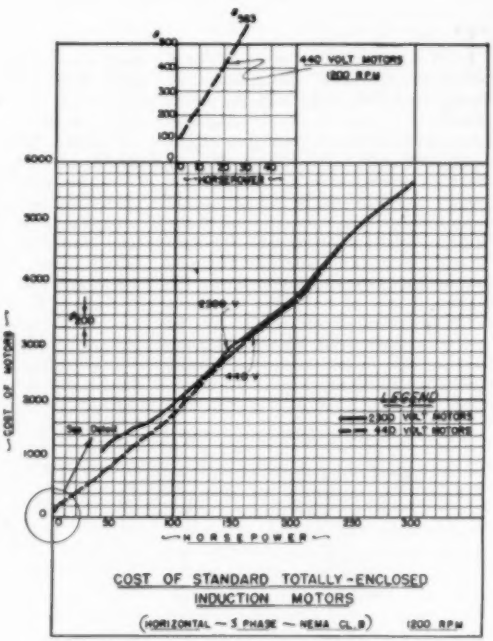


FIGURE 4

The initial cost of a motor installation involves several items. In general, however, the costs separate into two groups. *Group 1* includes the costs of the motor, the motor controller, and may or may not include a proportion of the installed cost of a low voltage substation since the latter depends on whether the motor feeds direct from the distribution system or requires a lower voltage. All of these costs with minor assumptions can be fixed and will be common to any similar motor installation. *Group 2* includes those costs which vary with each particular

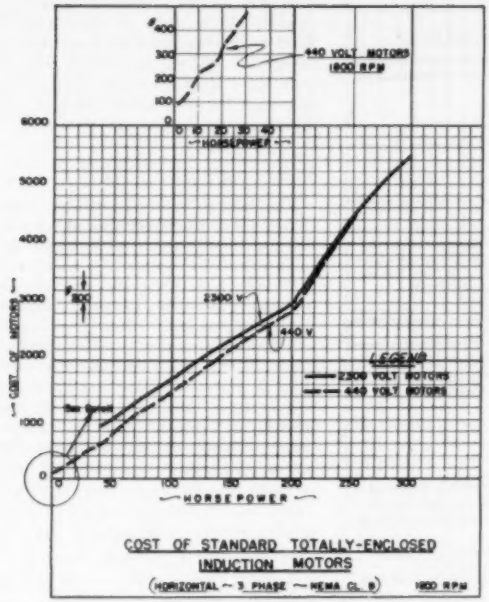


FIGURE 5

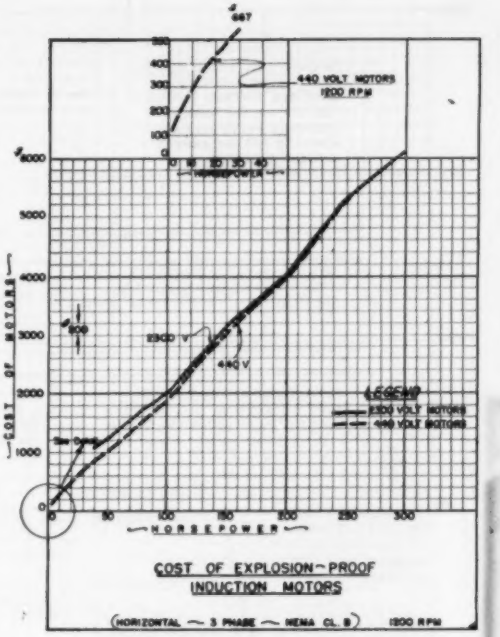


FIGURE 7

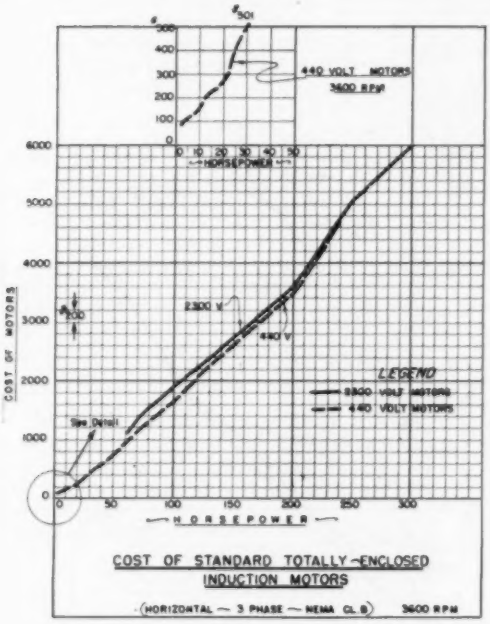


FIGURE 6

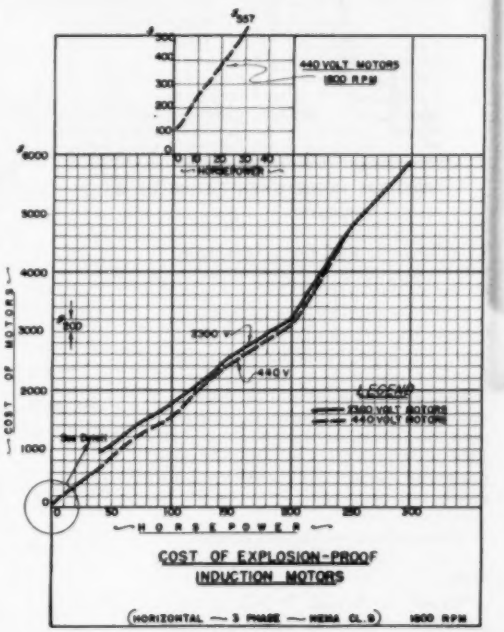


FIGURE 8

motor installation such as a percentage of the distribution system cost, a proportion of the switchroom building cost, a proportion of the bus cost, including the main breaker, and the motor power circuit cost.

In order to derive the difference in initial costs of motor installations when different voltages are considered, it is proposed to determine the gross difference in cost of the items in Group 1 for each voltage being compared.

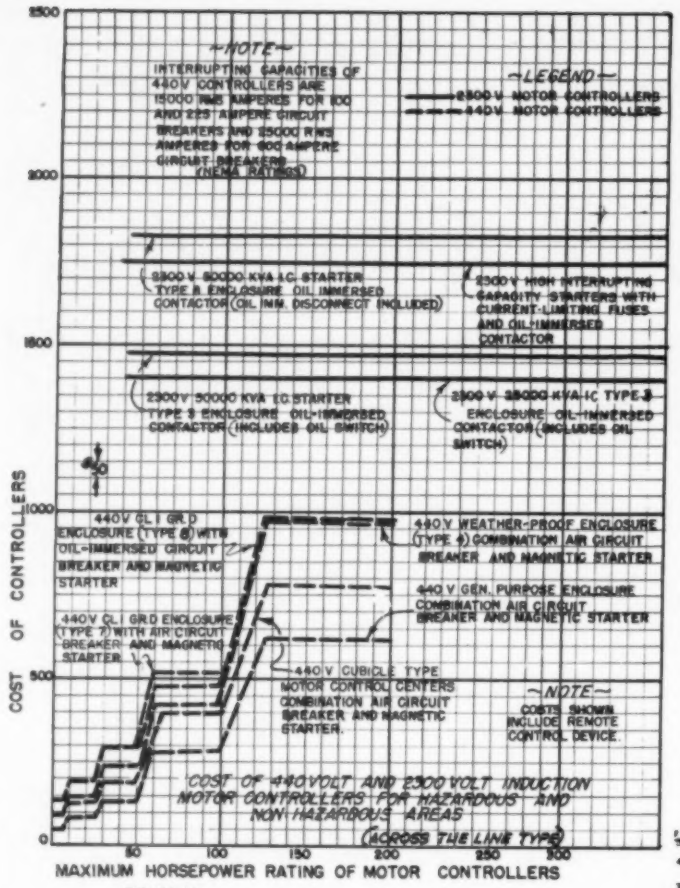

~NOTE~
INTERRUPTING CAPACITIES OF 440V CONTROLLERS ARE 15000 RMS AMPERES FOR 100 AND 225 AMPERE CIRCUIT BREAKERS AND 15000 RMS AMPERES FOR 600 AMPERE CIRCUIT BREAKERS (NEMA RATINGS)
~LEGEND~
2300 V. MOTOR CONTROLLERS
440 V. MOTOR CONTROLLERS
2300 V. 50000 KVA A.C. STARTER TYPE B ENCLOSURE OIL IMMERSED CONTACTOR (OIL IMM. DISCONNECT INCLUDED)
2300 V. HIGH INTERRUPTING CAPACITY STARTERS WITH CURRENT-LIMITING FUSES AND OIL-IMMERSED CONTACTOR
2300 V. 50000 KVA A.C. STARTER TYPE B ENCLOSURE OIL-IMMERSED CONTACTOR (INCLUDES OIL SWITCH)
2300 V. 25000 KVA A.C. TYPE B ENCLOSURE OIL-IMMERSED CONTACTOR (INCLUDES OIL SWITCH)
440V CL I GRD ENCLOSURE (TYPE 8) WITH OIL-IMMERSED CIRCUIT BREAKER AND MAGNETIC STARTER
440V WEATHER-PROOF ENCLOSURE (TYPE 4) COMBINATION AIR CIRCUIT BREAKER AND MAGNETIC STARTER
440 V GEN. PURPOSE ENCLOSURE COMBINATION AIR CIRCUIT BREAKER AND MAGNETIC STARTER
440V CL I GRD ENCLOSURE (TYPE 7) WITH AIR CIRCUIT BREAKER AND MAGNETIC STARTER
440 V CUBICLE TYPE MOTOR CONTROL CENTERS COMBINATION AIR CIRCUIT BREAKER AND MAGNETIC STARTER.
~NOTE~
COSTS SHOWN INCLUDE REMOTE CONTROL DEVICE.
COST OF 440 VOLT AND 2300 VOLT INDUCTION MOTOR CONTROLLERS FOR HAZARDOUS AND NON HAZARDOUS AREAS
(ACROSS THE LINE TYPE)
COST OF CONTROLLERS
MAXIMUM HORSEPOWER RATING OF MOTOR CONTROLLERS

FIGURE 10

This difference will then be reconciled with respect to the variable items included in Group 2.

While most of the items included in Groups 1 and 2 can be closely evaluated, certain considerations such as reliability, maintenance, etc., are contingent upon the details of the specific installation. Consequently, these items must be left to be appraised in the light of experience applicable to the particular installation being considered.

Comparison of Fixed Costs—Group 1

Motors

Figures 1 through 9 indicate the comparative costs of 440-volt and 2300-volt open type, standard totally-enclosed, and explosion-proof motors. It is interesting to note that the difference between the costs of 440-volt and 2300-volt motors of the same speed and horsepower is approximately the same irrespective of the enclosure considered. While data on the costs of 4000-volt motors have not been shown, these costs will run in general 30 percent more than 2300-volt motors, in the range between 75 to 250 h.p., the difference decreasing as the motor rating increases.

Motor Controllers

The costs of motor controllers vary considerably when voltages above 600 volts are compared with voltages below 600 volts. Controller costs for 2300-volt and 4000-volt motors are practically identical. The cost of across-the-line motor controllers for 440-volt and 2300-volt motors are illustrated in Figure 10. Various selections of across-the-line controllers are indicated for each voltage, depending first, on the degree of explosion hazard anticipated; second, on the preference for oil or air-break equipment; and last, on the interrupting capacities involved. The costs of reduced-voltage starters have not been considered in this report. In general, however, the use of reduced-voltage starters results in less cost difference between 2300-volt and 440-volt motor controllers and favors use of 2300 volts for motor sizes which would otherwise be 440-volt.

The degree of explosion hazard is obviously dependent upon the location of the control equipment. The National

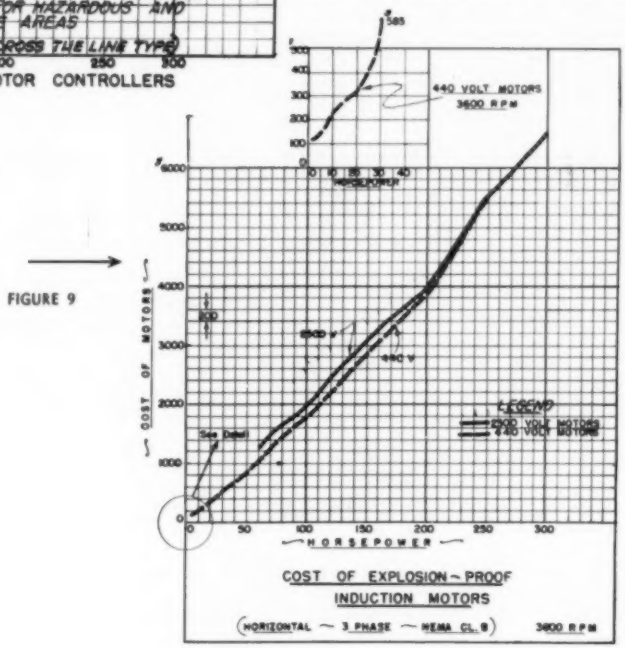


FIGURE 9

Electrical Code affords a guide for determining the type of equipment required once the source and extent of hazard are ascertained. The costs of enclosures considered and the order of magnitude is general purpose, weatherproof and Class 1, Group D, Division 1 enclosures.

The selection of oil or air-break equipment is still largely a matter of personal preference. It is generally maintained that oil-immersed equipment reduces the corrosion of controller parts from atmospheric attack. On the other hand, air-break equipment is generally preferred when corrosion is not of prime importance as contact life is appreciably increased with this type of equipment.

The interrupting capacity and instantaneous ratings of motor controllers materially affect their cost. The costs of 440-volt controller combinations shown in Figure 10 all utilize the ordinary molded case circuit breaker which has an interrupting capacity and, incidentally, a momentary rating of 15,000 root mean square amperes except the 600-ampere frame circuit breaker which is rated 25,000 rms amperes. The fact that these low range interrupting capacity circuit breakers are generally adequate when considering 440-volt controllers is indicated by the following excerpt from "Electric Motors in Industry" by Shoults, Rife and Johnson: *Heavy short circuits are largely limited to the higher voltage systems, 2200 volts and above. On low voltage circuits at 220-440 volts the reactance of current transformers, distribution systems, circuit breakers, bus structure and the short circuit arc itself are very appreciable in limiting the maximum short circuit. A vast amount of operating experience indicates that the short-circuit current on such low voltage systems will not be in excess of 20,000 rms amperes unless especially prepared short circuits are used.* Further, NEMA now recognizes contactor reactance as another limiting factor of short circuits on low-voltage systems.

Use of Circuit Breakers

Occasionally interrupting capacities of 440-volt installations will exceed the 20,000 rms. amperes and in such cases it is customary to use high interrupting capacity circuit breakers with the required motor control attachments. Since these instances are comparatively rare, no cost curves of such equipment have been included.

In the case of 2300- and 4000-volt motor controllers the interrupting capacity and instantaneous rating become extremely critical. This is due to the motor service originating generally directly from the distribution system with a resultant low impedance circuit to the fault. Therefore, a choice must be made, when considering 2300 and 4000-volt motor controllers, between a low interrupting capacity motor starter which requires additional equipment for interrupting heavy short circuits or a motor starter of high interrupting capacity which requires no supplemental equipment for interrupting short circuits. Reference to Figure 10 indicates the cost relation of these two basic combinations of high-voltage motor control as well as their relation to the cost of 440 volt motor controllers of various specifications.

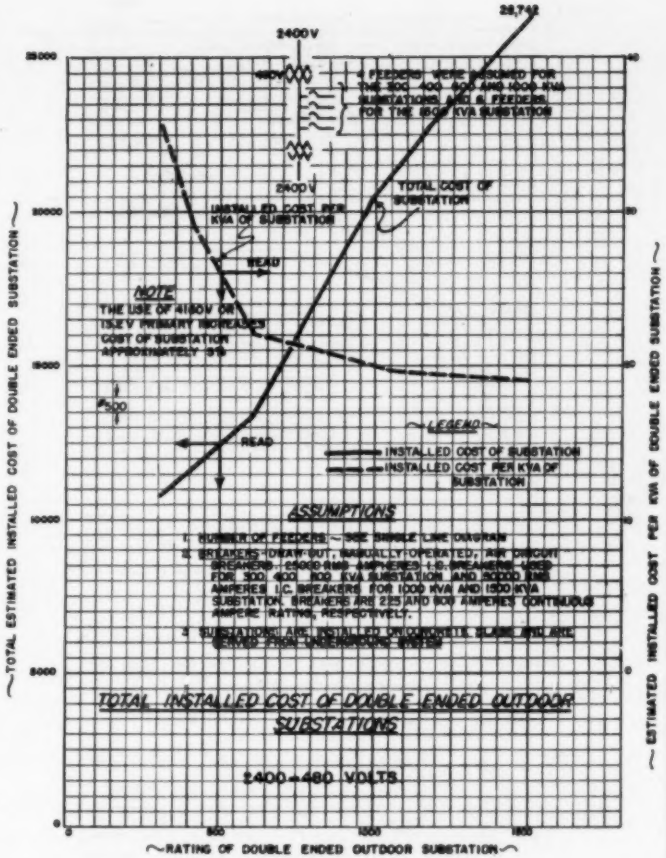

28,742
2400 V
480 V
4 FEEDERS WERE ASSUMED FOR THE 500, 400, 800 AND 1000 KVA SUBSTATIONS AND 8 FEEDERS FOR THE 1500 KVA SUBSTATION
2400 V
INSTALLED COST PER KVA OF SUBSTATION
TOTAL COST OF SUBSTATION
READ
NOTE
THE USE OF 4160 V OR 13.2 KV PRIMARY INCREASES COST OF SUBSTATION APPROXIMATELY 5%
500
READ
LEGEND
INSTALLED COST OF SUBSTATION
INSTALLED COST PER KVA OF SUBSTATION
ASSUMPTIONS
1. NUMBER OF FEEDERS — SEE SINGLE LINE DIAGRAM
2. BREAKERS DRAW OUT, MANUALLY OPERATED, AIR CIRCUIT BREAKERS 25000 RMS AMPERES I.S. BREAKERS USED FOR 500, 400, 800 KVA SUBSTATION AND 30,000 RMS AMPERES I.C. BREAKERS FOR 1000 KVA AND 1500 KVA SUBSTATION. BREAKERS ARE 225 AND 800 AMPERES CONTINUOUS AMPERE RATING, RESPECTIVELY.
3. SUBSTATIONS ARE INSTALLED DIAGRAMMATIC BUSING AND ARE FED FROM UNDERGROUND SYSTEM
TOTAL INSTALLED COST OF DOUBLE ENDED OUTDOOR SUBSTATIONS
2400-480 VOLTS
RATING OF DOUBLE ENDED OUTDOOR SUBSTATION
TOTAL ESTIMATED INSTALLED COST OF DOUBLE ENDED SUBSTATION
ESTIMATED INSTALLED COST PER KVA OF DOUBLE ENDED SUBSTATION

FIGURE 11

480-Volt Unit Substations

Since 480 volts is seldom feasible economically for distribution, it is necessary to install a 480-volt transformer substation to reduce the customary high distribution voltages for 440-volt motor use. Therefore, when the installation costs of 440-volt motors are compared with those of 2300-volt or 4000-volt motors, assuming direct connection to either 2400 or 4160-volt distribution, a proportion of the installed cost of the 480-volt substation must be included in the total cost of the 440-volt motor installation.

Figure 11 shows an installed-cost curve of double-ended outdoor 480-volt unit substations. Costs shown are for 2400-volt primary service. The use of a 4160-volt or 13.8-kv. primary service only increases the costs a negligible percentage unless the primary system capacity affects the assumed interrupting ratings of the load center circuit breakers. For the purpose of this article, the installed cost of a 1000-kva. substation will be used in subsequent comparisons, since it appears to represent the best compromise of cost per installed kva. consistent with the requirement of the load densities occurring in many refineries. The interrupt-

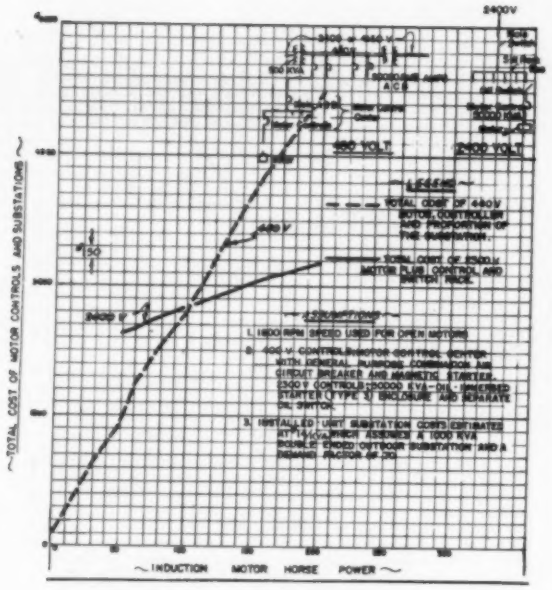


FIGURE 12

Total Costs of Motors, Controls, Installed Cost of Low-Voltage Substations and 2400-Volt Switch Rack for Non-Hazardous Areas Using Open-Type Motors and Controls.

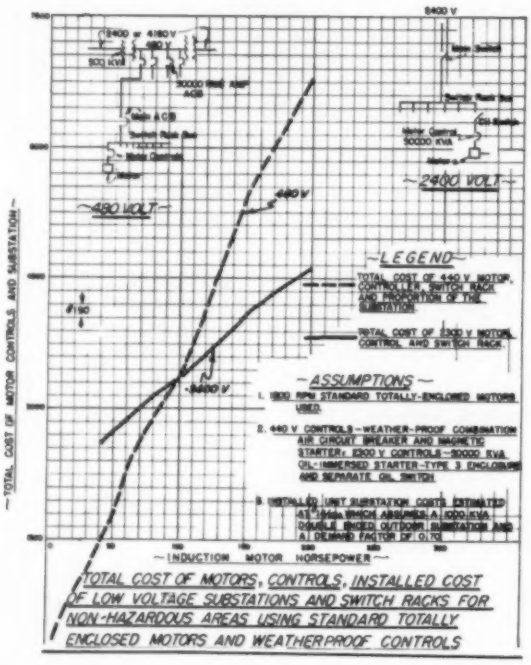

~TOTAL COST OF MOTOR CONTROLS AND SUBSTATION~
~INDUCTION MOTOR HORSEPOWER~
2400 VOLT
480 VOLT
440 V
2400 V
LEGEND
ASSUMPTIONS
TOTAL COST OF MOTORS, CONTROLS, INSTALLED COST OF LOW VOLTAGE SUBSTATIONS AND SWITCH RACKS FOR NON-HAZARDOUS AREAS USING STANDARD TOTALLY ENCLOSED MOTORS AND WEATHERPROOF CONTROLS

FIGURE 13

ing ratings of circuit breakers and other pertinent data applicable to the substation application costs are as indicated in Figure 11.

Total Costs of Motors, Controllers, and Installed Unit Substation

Group 1

Reviewing Figures 1 through 9, which illustrate the difference in costs of 440-volt and 2300-volt motors for various enclosures and for 1200, 1800 and 3600-rmp. speeds, it is apparent that the cost difference is not large in any case. At 40 h.p., the present cost of a 2300-volt motor is approximately $275 more than a 440-volt motor of the same speed and enclosure. This difference decreases as the motor size increases and at 250 h.p. the motor prices are identical. Therefore, the cost of the motor controllers, low voltage substations and switch racks must make for any significant difference in cost between 2300-volt and a 440-volt motor installation.

Examining Figure 10 which contains cost curves of various across-the-line 2300-volt and 440-volt motor-control combinations, it is significant that the cost of available 2300-volt controllers is the same for all horsepowers in the range under consideration (0-350 h.p.), whereas, 440-volt controllers increase in cost as the horsepower requirements increase. This fact is the principal reason why the 440-volt motor installations are considerably less costly than high voltage installations in the lower horsepowers. As the motor horsepower increases, the economical advantages which result from the use of low voltage motor controllers are rapidly offset by the cost of the 480-volt unit substation. As previously stated, the use of reduced-voltage starting for motors decreases the advantages arising from the use of 440-volt.

The installed cost of double-ended outdoor 2400/480-volt unit substations is shown in Figure 11. As previously stated, the cost of the 1000-kva. substation has been used as a basis for comparing the total costs of the motor installation factors included in Group 1. The various assumptions used in regard to the number of feeders, the interrupting capacities, etc., are indicated in Figure 11 and should be carefully appraised. The allocation of the unit substation costs to the total cost of a 440-volt motor installation is even more significant than the cost of motor controls, when ascertaining the most economical motor voltage. One important assumption is the demand factor (ratio of maximum actual load to the total connected load) of 0.70 and a diversity factor (ratio of the

maximum demands of parts of a system to the maximum demand of the total system) of 1.0. Application of these factors to the costs of the 1000-kva. unit substation results in an installed cost per kva. of connected load of approximately $14. This amount has been used to obtain the total cost of the motor, the motor controller, controller switch rack, and a proportion of the installed cost of the 480-volt unit substation. These total costs are shown in Figures 12, 13, and 14.

Figure 12 presents a comparison of the cost of 440-volt and 2300-volt motor installations, assuming open-type motors; 440-volt motor-control centers with a main breaker; a weatherproof 480-volt unit substation; weatherproof 2300-volt motor controls with separate oil switch; and a 2400-volt switch rack with a main oil switch. A similar comparison except using totally enclosed motors and weatherproof controlls for both 440-volt and 2300-volt installations is shown in Figure 13, and similar data applicable to explosion-proof motors and controls are shown in Figure 14.

100 Horsepower Line

It is significant to note that the total cost curves shown in Figures 12, 13 and 14 all indicate that when appraising motor, motor control, unit substation and switch rack costs that savings are definitely indicated by the use of 440-volt for installations of 100 horsepower and less. Above 100 horsepower, 2300-volt motors indicate an economy. This conclusion will also hold true for 4000-volt motor installations since a 4000-volt motor installation would exceed the cost of an equivalent 2300-volt installation by only a small percent. These conclusions are based on consideration of Group 1 factors only and must be reviewed in consideration of factors included in Group 2 which are subsequently discussed.

It probably should be mentioned at this point that, even though the installation of certain size motors may show economies, there are certain minimum horsepower ratings less than which it is not practicable to employ certain voltages. These minimum ratings originate with design considerations imposed by the inherent characteristics of the motors themselves. The following table of minimum and maximum horsepower ratings appears in several handbooks and is generally recognized by the electrical industry.

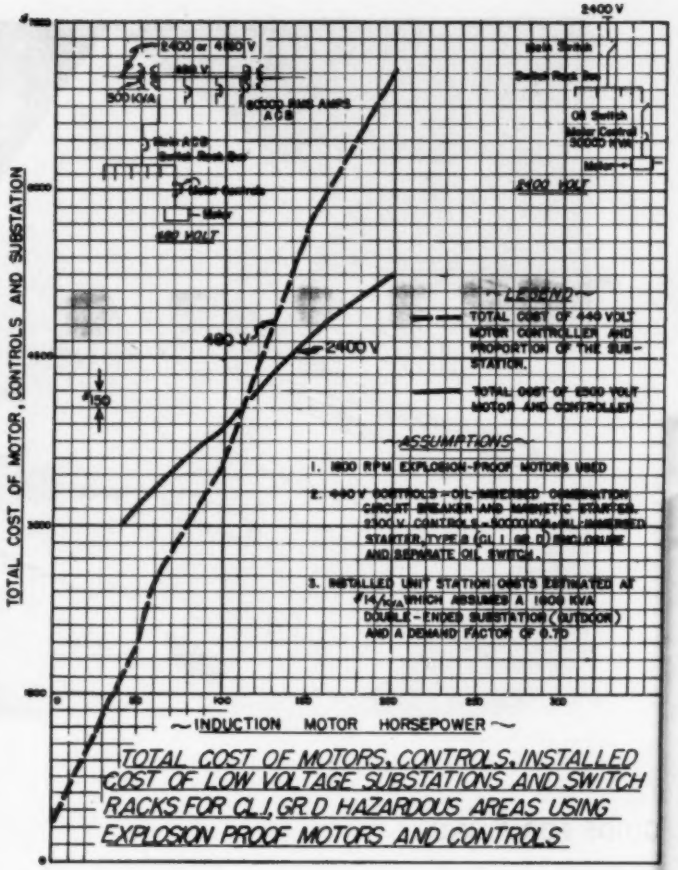
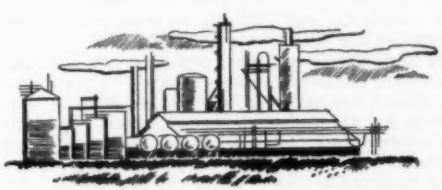

TOTAL COST OF MOTOR, CONTROLS AND SUBSTATION
INDUCTION MOTOR HORSEPOWER
480 V.
2400 V
LEGEND
TOTAL COST OF 440 VOLT MOTOR CONTROLLER AND PROPORTION OF THE SUBSTATION.
TOTAL COST OF 2300 VOLT MOTOR AND CONTROLLER
ASSUMPTIONS
1. 1800 RPM EXPLOSION-PROOF MOTORS USED
3. INSTALLED UNIT STATION COSTS ESTIMATED AT $14/kva WHICH ASSUMED A 1000 KVA DOUBLE-ENDED SUBSTATION (OUTDOOR) AND A DEMAND FACTOR OF 0.70
TOTAL COST OF MOTORS, CONTROLS, INSTALLED COST OF LOW VOLTAGE SUBSTATIONS AND SWITCH RACKS FOR CL I, GR D HAZARDOUS AREAS USING EXPLOSION PROOF MOTORS AND CONTROLS

FIGURE 14

Voltages	Preferred Horsepower Limits
110	No minimum;—15 h.p. maximum
220	No minimum;—200 h.p. maximum
440 or 550	No minimum;—500 h.p. maximum
2200	40 h.p. minimum;—No maximum
4000	75 h.p. minimum;—No maximum
6600	400 h.p. minimum;—No maximum

End of Part I. Part II will appear in an early issue.



GUIDE FOR FILING–

Decimal Classification System For Chemical Engineering

W. L. BOLLES
Monsanto Chemical Company,
Texas City, Texas

***THE STAGGERING** volume of technical data, notes, reports, references, and the like, which most processmen seem to accumulate as they get deeper into their profession, can become an invaluable source of information and guidance in times of need—if the material can be so arranged and filed that any specific item desired is available without too much difficulty. One engineer's solution to this complex problem is presented here. To quote the author, "I have been using this system with considerable success on my own files for several years. I now have four filing-cabinet drawers, ten loose-leaf notebooks, and a couple of boxes of bibliography index cards, all classified and filed by the system. In addition, I have given copies of the system to several score interested persons, many of whom have adopted the system for their own files."*

Certainly the problem is a universal one and a serious one, not only for individual engineers, but also for the technical files of research groups, operating companies, engineer-contractor concerns, equipment manufacturers, and similar organizations. It is recommended, therefore, that this article be given careful attention by all who are concerned with indexing technical information. Since the system here outlined is quite flexible, it can be used in its present form, or it can be modified to the specific requirements of almost any technical group.

ONE of the most troublesome and irritating problems confronting chemical engineers is that of filing and relocating the data, notes, references, reports, and other material of this nature used in the practice of the profession. Most engineers approach the problem by means of a simple alphabetical index. However, it is usually found that as the years pass, the amount of material filed becomes so large and the number of subject headings so great that it is very difficult to locate specific information when needed. The situation is further complicated by the fact that each item of information can usually be filed under any one of many different subject

headings, and one usually comes to depend more and more upon memory to make the system work.

Presented herein is a decimal classification system for chemical engineering information which may be of interest as a possible solution to the filing problem. This system, modeled after the well known *Dewey Decimal System*, may be extended to provide for the classification of an almost unlimited amount of technical material pertaining to chemical engineering, and still permit rapid recall of any specific item when needed. The outstanding feature of this type of system is that it is based upon logical classification rather than alphabetical arrangement. In the classification system closely related subjects are located near one another in the file thus providing a very convenient arrangement. As a result of this arrangement, cross-indexing is usually neither necessary nor desirable.

The system given here was designed primarily for individual use by chemical engineers for the filing of data, reprints, catalogs, notes, and other similar material. It may also be found useful in the maintenance of a card file of chemical engineering literature references. However, the system is not expected to be appropriate for chemists or other technologists, nor for use in library research or company filing, although it may be found of value as an example in the development of special classification systems to fill these needs.

The development of a logical and comprehensive classification system for any purpose is indeed a most difficult task. It is recognized that the classification system for chemical engineering given here is far from perfect. However, in view of the fact that no classification system for chemical engineering has as yet appeared in the literature, it is hoped that this work will stimulate further interest in this field.

Indexing vs. Classification

It is generally accepted that there are two distinct systems of organizing or filing information: *indexing* and *classification*. *Indexing* is based upon alphabetizing subject headings, whereas *classification* is based upon an orderly and logical arrangement according to some predetermined plan. Although the technique of indexing and classification has been studied for quite a long time, the subject as applied to the chemical field has been receiving increased attention during the past year.[1,2,5,6]

Indexing is by far the most popular type of filing system. This is probably due to the apparent simplicity of this system. It is recognized that indexing is quite satisfactory for filing information concerning which there are definite and recognized names, for example, chemical compounds. However, the indexing of ideas and broad subjects as frequently encountered in chemical engineering is considerably more difficult because of the problem of selecting suitable titles. One such problem is the question of whether to index under specific or general subject titles. For example, one may index information on rotameters under the specific title "Rotameters," or the more general title "Flow Measurement," or the still more general title "Fluid Flow." Similarly, information on the sizing or fractionation towers might be indexed under "Tower Sizing," "Tower Design," "Fractionation," or "Distillation."

Thus with indexing there are always several different possible places for

TABLE 1
BASIC DIVISIONS

000	Chemical engineering in general
100	Pure science
200	Applied science
300	Physical and chemical data
400	Unit operations
500	Chemical technology
600	Economics and management
700	Other branches of engineering
800	Experience
900	Miscellaneous

TABLE 2
SECONDARY HEADINGS

000	CHEMICAL ENGINEERING IN GENERAL
010	General; Philosophy; Theories; Utility
020	Outline; Classification
030	Chemical engineering as a profession
040	Research, industry, and government
050	Literature
060	Societies
070	Chemical and industrial organizations
080	Education
090	History; Biographies
100	PURE SCIENCE
110	Mathematics
120	Astronomy
130	Physics
140	Chemistry
150	Geology
160	Paleontology
170	Biology; Anthropology
180	Botany
190	Zoology
200	APPLIED SCIENCE
210	Mathematical tables
220	Weights and measures
230	Mathematics
240	Physics
250	Chemistry
260	Physical chemistry
270	Thermodynamics
280	Industrial chemical calculations
290	Miscellaneous physical and chemical principles
300	PHYSICAL AND CHEMICAL DATA
310	Inorganic compounds (Classification by compound)
320	Organic compounds (Classification by compound)
330	Miscellaneous substances (Classification by compound)
340	Physical data (Classification by property)
350	Thermodynamic data (Classification by property)
360	Chemical data (Classification by property)
370	Miscellaneous data (Classification by property)
380	Experimental methods
390	Experimental apparatus
400	UNIT OPERATIONS
410	Fluid flow
420	Heat transfer
430	Diffusional operations
431	Distillation
432	Absorption
433	Extraction
434	Adsorption
435	Drying
440	Mechanical operations
441	Storing of materials
442	Movement of materials
443	Crushing and grinding
444	Mixing; Agitation
445	Mechanical separations
450	Chemical operations; Kinetics
460	Miscellaneous operations
461	Evaporation
462	Refrigeration
463	Humidification; Cooling towers; Spray ponds; Air conditioning
500	CHEMICAL TECHNOLOGY
502	Abrasives; Polishes
504	Adhesives; Glue; Bonding materials
506	Agricultural products; Fertilizers
508	Alcoholic beverages (See 538 also)
509	Atomic energy
510	Bleaching compounds
512	Building materials; Cement; Concrete
514	Carbon black
516	Ceramics
518	Chemicals
520	Coal; Coke; Coal tar
522	Coatings; Enamels; Finishes (See 560 also)
524	Cosmetics; Perfume
526	Detergents; Wetting agents; Emulsifiers (See 580 also)
528	Drugs; Pharmaceuticals
530	Dyes
532	Electrochemical industries; Electric furnaces; Electrolytic cells
534	Electroplating
536	Explosives; Chemical warfare
538	Fermentation (See 508 also)
540	Foods; Beverages
542	Fuels; Combustion
544	Gases; Gas purification
546	Glass
548	Ink
550	Insecticides
552	Leather
554	Matches
556	Metals
558	Oils; Fats; Waxes
560	Paint; Varnish; Lacquer (See 508 also)
562	Paper
564	Petroleum
566	Photography
568	Pigments (See 560 also)
570	Plastics
572	Power generation; Mechanical transmission
574	Resins; Gums
576	Rubber
578	Sanitation; Sewage disposal
580	Soap
582	Solvents
584	Textiles; Synthetic fibers
586	Waste disposal
588	Water
590	Wood; Cellulose
600	ECONOMICS AND MANAGEMENT
610	Administration; Top management planning
620	Research and development
630	Economic evaluation
640	Organization
650	Personnel management
660	Production management
670	Finance
680	Sales
690	Miscellaneous economic and management factors
700	OTHER BRANCHES OF ENGINEERING
710	Civil engineering
720	Mechanical engineering
730	Electrical engineering
800	EXPERIENCE
900	MISCELLANEOUS

filing each piece of information. Consequently the filed material on each subject usually becomes distributed among many different subject headings and quite frequently much useful information is overlooked when needed. Of course this problem can be overcome through the use of extensive cross-indexing. *Chemical Abstracts*, for example, employs a large number of cross-index entries for each reference listed. However, it should be apparent that a complicated cross-indexing system is too cumbersome and impractical for use in one's personal data file.

Consider, now, the classification system as an approach to the problem of organizing written material. This type of system has been developed to an extremely high degree by Melvil Dewey in his *Decimal System of Classification*,[3] which is perhaps the most widely used classification system for general knowledge. The *Dewey Decimal System*, as it is commonly known, divides all knowledge into ten broad classes to which are assigned numbers from 0 to 9 in the hundreds place:

000	General
100	Philosophy
200	Religion
300	Sociology
400	Philology
500	Natural sciences
600	Useful arts
700	Fine arts
800	Literature
900	History

Each of these classes is then divided into ten parts and assigned digits 0 to 9 in the tens place. Thus the Useful Arts are subdivided as follows:

600	Useful arts in general
610	Medicine
620	Engineering
630	Agriculture
640	Domestic economy
650	Communication and commerce
660	Chemical technology
670	Manufactures
680	Mechanical trades
690	Building

Continuing further, Engineering is subdivided as follows:

620	Engineering in general
621	Mechanical engineering
622	Mining engineering
623	Military engineering
624	Bridge and structural engineering
625	Railroad and highway engineering
626	Canal engineering
627	River and harbor engineering
628	Sanitary engineering and water works
629	Other branches of engineering

Thus the classification system employs an entirely different approach from conventional indexing. The entire field is first divided into a small number of broad classes. Then each of these classes is divided into a short series of logical divisions; and each of these divisions is subdivided into its logical components. This process of subdivision may be continued indefinitely to provide any desired degree of classification.

TABLE 3
PETROLEUM INDUSTRY OUTLINE

564	Petroleum industry
.0	Petroleum technology in general
.01	Definitions; Philosophy; Outline
.02	Statistics; Facts
.03	Societies and organizations
.04	Journals
.05	Bibliographies; Abstracts
.06	Patents
.07	Companies; Plants; Refineries
.08	Research; Organizations
.1	Fundamentals; Chemistry of petroleum materials
.2	Physical and chemical data
.21	Petroleum products
.22	Physical data
.23	Thermal and thermodynamic data
.24	Chemical data
.25	Miscellaneous data
.26	Experimental methods
.27	Experimental apparatus
.3	Analysis and testing
.31	Analysis for hydrocarbons
.32	Analysis for non-hydrocarbons
.33	Analysis and testing of petroleum products
.34	Special tests
.35	Testing equipment
.4	Raw material; Petroleum
.41	Occurrence of petroleum
.42	Composition of petroleum
.43	Prospecting
.44	Drilling
.45	Producing
.46	Transportation
.5	Refining
.51	Unit processes
.52	Treating processes
.53	Separation processes
.54	Refining of petroleum products
.6	Products; Utilization; Applications
.61	Engine fuels
.62	Lubricants
.63	Burner fuels
.64	Solvents
.65	Chemicals
.66	Specialties
.67	Miscellaneous products
.7	Economics

There are many advantages to be gained by the adoption of a classification system for filing. Generally speaking, the classification system provides "a place for everything and everything in its place." With a well-designed classification system there is usually only one place to file any given piece of material. Conversely, there is only one place to look when it is desired to refer to some item in the file. Hence there is practically no need for cross-indexing in the use of a classification system. For applications where there is only one available copy of each item, for example, a reprint, graph, or set of notes, this advantage is practically a necessity.

Another advantage of the classification system is that the orderly and logical arrangement is a great help in locating information in the file. Closely related subjects are located near one another in the file for convenient reference purposes. Often this arrangement will help unearth much useful material which has been forgotten and might otherwise be overlooked.

Still another advantage of the classification system is that code numbers may be conveniently utilized to indicate subject headings. By means of a decimal notation, one can label the subject matter on filing folders, data sheets, and bibliography cards in order to facilitate filing. This is particularly useful in the efficient utilization of secretarial help.

Development of the System

At first it was thought that perhaps a classification system for chemical engineering could be developed within the framework of the *Dewey Decimal System*. However, the Dewey system was found to be so broad that a specialized subject such as chemical engineering is all but lost within the complexity of the comprehensive system. Hence it seemed more practical to develop an entirely new classification system especially designed for chemical engineering.

The first step was to gather together a comprehensive list of the chief subjects in which chemical engineers are interested. This list was compiled with the help of Perry's *Chemical Engineers' Handbook*, Walker, Lewis, McAdams, and Gilliland's *Principles of Chemical Engineering*, Riegel's *Industrial Chemistry*, Nelson's *Petroleum Refinery Engineering*; the journals *Industrial and Engineering Chemistry*, *Transactions of the American Institute of Chemical Engineers*, and *Chemical Engineering Progress*; and many other standard reference works.

Upon the completion of this list of chemical engineering subjects, a study was made to select a small number of broad classes under one of which every subject in the comprehensive list could be classified. The classes chosen, as given in Table 1, are: Chemical Engineering in General, Pure Science, Applied Science, Physical and Chemical Data, Unit Operations, Chemical Technology, Economics and Management, Other Branches of Engineering, Experience, and Miscellaneous. Each of these broad classes was then subdivided into its logical components as shown in Table 2. From this point on, subjects were subdivided and resubdivided in a logical and orderly fashion until a place was provided in the system for every subject contained in the original list.

Description of the System

A brief examination of the classifica-

tion system will reveal that it contains a very wide scope of subjects, including not only general topics of interest to all chemical engineers, but also a great number of topics of special interest to chemical engineers in the petroleum industry.

The subdivision of the first two main classes, 000 — Chemical Engineering in General, and 100—Pure Science is self explanatory. The third class, 200—Applied Science, is intended to contain such applications of mathematics, physics, and chemistry as cannot be included in the preceding class, Pure Science; or in the three following classes, Physical and Chemical Data, Unit Operations, and Chemical Technology. While "Applied Science" is not an entirely satisfactory title, the subdivision of this class should clearly indicate its scope.

300—Physical and Chemical Data includes all data, correlations of data, and methods of estimating and evaluating data. The first three subdivisions, 310 through 330, are based upon classification by type of substance, whereas the next four subdivisions, 340 through 370, are based upon classification by type of property. This is necessary because some data are classifiable in only one of these two ways. For example, a compilation of the various properties of a given substance is best classified in 310 through 330, whereas a compilation of the values of one property for a number of substances is best classified in 340 through 370. Of course, when one wishes to look up a specific property of a specific substance, he may not know whether to look first under the substance or the property, but it takes only a moment to refer to both classifications.

It will be noted that 400—Unit Operations is divided into Fluid Flow, Heat Transfer, Diffusional Operations, Mechanical Operations, Chemical Operations, and Miscellaneous Operations. In keeping with the theory of the decimal classification system, those topics which are general and pertain to all the unit operations are grouped together under 400—Unit Operations in General. These consist of the Theory of Unit Operations, Nomenclature, Units of Measurement, Material Balances, Heat Balances, Equipment in General, Instrumentation and Control, and High-Pressure Technique.

Since fluid flow and heat transfer are perhaps the most basic unit operations, they are given a very prominent position among the unit operations. By Diffusional Operations is meant those unit operations in which diffusion is a key factor. The Mechanical Operations are mechanical in the sense that they do not, in general, involve heat transfer, diffusion, or chemical reaction. The classification of chemical reactions along with the unit operations is in keeping with the increasing emphasis being given to chemical kinetics and reactor design independent of the unit process involved. The Miscellaneous Operations, then, include those operations which involve two or more of the other unit operations. Refrigeration, for example, may involve fluid flow, heat transfer, and diffusion.

It will be noted that each unit operation is broken down into eight divisions: General Principles, Design Data, Mathematical Treatment, Design, Economics, Equipment, Operation, and Applications. Incidentally, the section on design data is provided for classifying data especially pertinent to the particular unit operation, and the equipment section is provided for classifying catalogs, specifications, and other similar material.

It was found necessary to deviate somewhat from the strict decimal system in classifying 500—Chemical Technology. It is practically impossible to classify all branches of the chemical and related industries into ten classes so as to permit the usual decimal breakdown. Hence the 500 series was broken into 100 parts. Of these only about 40 were used. These 40 industries were then placed in alphabetical order to facilitate use, and assigned even numbers so that additional industries may be inserted in alphabetical order if desired. For example, 509—Atomic Energy was added to the system after the other industries were already assigned numbers.

Popular Filing Method

The well-known "Where 'Tis?"—unimproved, unclassified and undesirable—system that prevails in far too many professional bailiwicks.

Petroleum Technology in Detail

It will be noted that 564—Petroleum Technology is classified in rather complete detail for the benefit of those in the petroleum industry. Also classified, but in less detail, are 518—Chemicals, and 556—Metallurgy. Since the chemical technology of a particular industry can be properly classified only by one specializing in the field, the subdivision of the other industries is left to those more qualified for the task. However, the foundation is provided for the classification of any branch of technology, and the detailed petroleum breakdown should be found helpful as a guide.

564—Petroleum Technology is classified into eight main divisions: Petroleum Technology in General; Fun-

damentals and Chemistry of Petroleum Materials; Physical and Chemical Data; Analysis and Testing; Raw Material, Petroleum; Refining; Products, Their Utilization and Applications; and Economics.

600—Economics and Management is classified into Administration and Top Management Planning, Research and Development, Economic Evaluation, Organization, Personnel Management, Production Management, Finance, Sales, and Miscellaneous.

For the filing of material pertaining to fields of engineering other than chemical, 700—Other Branches of Engineering is provided.

800—Experience is included for the classification of material in connection with one's work and experience. Here may be filed letters, reports, memoranda, calculations, and material pertaining to problems worked on. Persons having been associated with more than one organization may wish to assign numbers such as 810, 820, and 830 to each company. These may then be subdivided in some manner appropriate to the filing needs in each instance. The company organizational chart has been found to provide a good basic framework for the development of this part of the system.

The final main division, 900—Miscellaneous, is provided for the filing of miscellaneous material not readily classifiable in one of the other nine divisions. This division might be conveniently used for material not related to chemical engineering, or for any other purpose. The subdivision of this class is left up to the individual.

Use of the System

The use of the decimal classification system for classifying and filing material is very simple. Each piece of material is marked with the appropriate code number and arranged in numerical order. For example, data on pressure drop in pipe are marked 413.2, equilibrium constant data for petroleum hydrocarbons are marked 564.225.55, and cost data on steam are marked 633.131. This system may be used in connection with notebooks, card files, and cabinet files. For the purpose of selecting the proper classification, the summary tables provided should be found very useful.

It may be found desirable in some instances to utilize a small amount of cross-indexing. This may be easily accomplished by inserting at the appropriate places in the file cross-reference notes giving the location of the original material.

Even though the system as given is quite detailed, one may wish to file material for which there seems to be no place in the system. The best rule that can be given is to place such material with the topic with which it is most closely related. For example, an article dealing with fluid flow through porous solids may be classified with 413.7—Flow in Packed Beds.

Although the system includes very fine subdivision of certain subjects, it may not be desirable for the individual to use the full extent of this subdivision. For example, if one has only a small amount of material on heat transfer, he would do well to place it all together in one filing folder labeled 420, rather than placing one chart in 423.24, another in 424.14, and still another in 426.3. The only reason for subdividing a subject is that the amount of material to be filed under the subject has become so bulky that it is difficult to find one's way through it. When the quantity of material filed under any one classification becomes so great as to be unwieldy, the subject should by all means be subdivided. If the necessary subdivision is not provided in the system herein presented, it may be added as needed by the individual. One of the most attractive features of the classification system is that it is capable of infinite expansion in any desired direction.

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A Decimal Classification System for Chemical Engineering

000	**Chemical engineering in general**
010	General; Philosophy; Theories; Utility
020	Outline; Classification
030	Chemical engineering as a profession
031	Definition
032	Professional ethics
033	Statistics
034	Professional development
040	Research, industry, and government
041	Research in general
042	Research and industry
043	Government research
044	Patents and the patent system (See 626 also)
045	National scientific planning
046	National Roster of Scientific and Specialized Personnel
047	Wartime deferment of scientists and technologists
050	Literature
051	Library economy
.1	Libraries
.2	Standard reference works and journals
.3	Library research; Literature surveys
.4	Special reasearch methods; Punch cards, etc.
052	Books; Book lists, catalogs, and advertisements
053	Periodicals; Journals
054	Government bulletins
055	Trade literature
056	Bibliographies
057	Abstracts
060	Societies
061	Chemical and engineering societies
.1	American Chemical Society
.11	Division of Petroleum Chemistry
.2	American Institute of Chemical Engineers
.3	American Society for Advancement of Science
062	Professional societies Alpha Chi Sigma, etc.
063	Honorary societies Tau Beta Pi, Sigma Xi, etc.
070	Chemical and industrial organizations
071	Chemical and manufacturing companies
072	Industrial research organizations
073	Process engineering, contracting, and construction companies
074	Equipment manufacturers
080	Education
081	Schools; Colleges; Universities
082	Chemical engineering education
083	Personal records; Class notes, etc.
090	History; Biographies
100	**Pure science**
110	Mathematics
110	General
.1	Recreational mathematics
111	Number theory; Arithmetic
112	Algebra
113	Geometry
.1	Plane geometry; Euclidean geometry
.2	Solid geometry; Volumetric geometry
.3	Analytical geometry
.4	Descriptive geometry
114	Trigonometry
115	Calculus
.1	Infinitesimal calculus
.2	Differential calculus
.3	Integral calculus
.4	Calculus of finite differences
116	Differential equations
117	Probability
118	Special mathematical topics
119	Modern developments in mathematics
120	Astronomy
130	Physics
131	Mechanics
132	Physics of liquids
133	Physics of gases
134	Sound; Acoustics
135	Light; Radiation; Optics
136	Heat
137	Electricity
138	Magnetism
139	Molecular, atomic, and nuclear physics
140	Chemistry
141	Theoretical and physical chemistry
.1	In relation to physical states
.11	Solids
.12	Liquids
.13	Solutions
.14	Gases
.15	Colloid chemistry
.2	Thermodynamics
.3	Kinetics
.4	Electrochemistry
.5	Nuclear chemistry
.6	Electronics
.7	Catalysis
142	Analytical chemistry
.1	Qualitative inorganic
.2	Quantitative inorganic
.3	Qualitative organic
.4	Quantitative organic
.5	Analyses
143	Inorganic chemistry
.1	Elements
.2	Acids
.3	Bases
.4	Salts
.5	Oxides
.6	Halogen compounds
.7	Nitrogen compounds
.8	Sulfur compounds
.9	Phosphorous compounds

144 Organic chemistry
.1 Aliphatic compounds
.11 Hydrocarbons
.12 Alcohols
.13 Acids
.14 Aldehydes; Ketones
.15 Ethers; Esters
.16 Halogen compounds
.17 Nitrogen compounds
.18 Sulfur compounds
.19 Metal-organic compounds
.2 Aromatic compounds
.21 Benzene derivatives
.22 Naphthalene derivatives
.23 Complex-ring derivatives
.3 Alicyclic compounds
.4 Heteocyclic compounds
145 Crystallography
146 Mineralogy
150 Geology
160 Paleontology
170 Biology; Anthropology
180 Botany
190 Zoology

200 **Applied science (in chemical engineering)**
210 Mathematical tables
220 Weights and measures
221 Dimensional analysis
222 Definition of units
223 Conversion factors
230 Mathematics
231 Calculus
232 Differential equations
233 Numerical analysis
234 Graphical analysis
.1 Graphical representation
.2 Graphical solution of problems
.3 Alignment charts
.4 Special types of charts
.5 Slide rules
235 Empirical equations
236 Correlation of experimental data
237 Statistical analysis and theory of errors
238 Calculating machines
239 Special applications of mathematics
240 Physics
250 Chemistry
260 Physical chemistry
270 Thermodynamics
280 Industrial chemical calculations
290 Miscellaneous physical and chemical principles

300 **Physical and chemical data**
310 Inorganic compounds
311 Elements
312 Acids
313 Bases
314 Salts
315 Oxides
316 Halogen compounds
317 Nitrogen compounds
318 Sulfur compounds
319 Phosphorous compounds
320 Organic compounds
321 Aliphatic compounds
.1 Hydrocarbons
.2 Alcohols
.3 Acids
.4 Aldehydes; Ketones
.5 Ethers; Esters
.6 Halogen compounds
.7 Nitrogen compounds
.8 Sulfur compounds
.9 Metal-organic compounds
322 Aromatic compounds
.1 Benzene derivatives
.2 Naphthalene derivatives
.3 Complex-ring derivatives
323 Alicyclic compounds
324 Heterocyclic compounds
330 Miscellaneous substances
340 Physical data
341 Melting, boiling, and critical points
342 Densities
.1 Solids
.2 Liquids
.3 Gases; PVT relations
343 Vapor pressures
344 Viscosities
345 Phase equilibria
.1 Solid-solid systems; Solid solutions
.2 Solid-liquid systems; Solubility
.3 Solid-vapor systems; Sublimation
.4 Liquid-liquid systems; Solubility
.5 Liquid-vapor systems
.51 Pure components
.52 Binary systems
.53 Ternary systems
.54 Quaternary systems
.55 Multicomponent systems; Equilibrium constants
.56 Azeotropes
346 Surface tensions; Interfacial tensions
347 Thermal conductivities
348 Diffusivity coefficients
350 Thermal and thermodynamic data
351 Specific heats
352 Latent heats
353 Heats of solution and sublimation
354 Fugacities; Activity coefficients
355 Enthalpies
356 Entropies
357 Free energies
360 Chemical data
361 Molecular weights; Formulas; Structures
362 Chemical reactions
363 Chemical equilibria; Dissociation pressures
364 Heats of formation
365 Heats of reaction and combustion
366 Free energies of reaction
370 Miscellaneous data
380 Experimental methods
390 Experimental apparatus

400 **Unit operations**
400 Unit operations in general
401 Theory of unit operations
402 Nomenclature
403 Units of measurement
404 Material balances
405 Heat balances
406 Equipment in general
.1 Catalogs; Specifications
.2 Manufacturers; Distributors; Salesmen
.3 Materials of construction
.31 Metallic materials
.32 Non-metallic materials
.33 Corrosion; Erosion (See 556.64 also)
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.2 Pressure measurement
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.4 Level measurement
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.7 Impulse transmission
408 High-pressure technique
410 Fluid flow
411 General principles; Fundamentals; Theories
.1 Fluid statics
.2 Pressure gages and manometers
.3 Bernouli's Theorem
.4 Theory of dimensionless similitudes
.5 Streamline and turbulent flow
412 Design data for fluid flow
413 Mathematical treatment; Fluid flow calculations
.1 Flow in open channels
.2 Flow in pipe and tubing
.3 Flow in annuli, square channels, etc.
.4 Flow in valves and fittings
.5 Contractions, expansions, etc.
.6 Flow measurement (See 407.3 also)
.61 Static pressure
.62 Local velocity
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.64 Differential meters; Orifices; Venturis
.65 Area meters; Rotameters
.66 Weirs
.67 Quantity meters; Positive-displacement meters
.68 Dilution metering
.7 Flow in packed beds and towers
.8 Flow in equipment, heat exchangers, etc.
.9 Flow of fluidized solids
414 Design of fluid flow systems
415 Economics of fluid flow; Optimum pipe diameter, etc.
416 Equipment; Pipe and fittings
417 Operation and maintenance of fluid flow equipment
418 Applications of fluid flow
420 Heat transfer
421 General principles; Fundamentals; Theories
.1 Conduction
.2 Convection
.3 Radiation
422 Design data for heat transfer
423 Mathematical treatment; Heat transfer calculations
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.2 Convection; Convection coefficients
.21 Natural convection
.22 Forced convection inside tubes (including annuli)
.23 Forced convection outside tubes (including fintubes)
.24 Boiling liquids
.25 Condensing vapors
.26 Heat transfer in packed beds
.3 Radiation
.31 Radiation between solid surfaces
.32 Radiation involving gases
.33 Radiation involving suspended particles
424 Design of heat transfer equipment
.1 Heat exchangers
424.11 Design and construction
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.13 Overall coefficient
.14 Fouling factors
.15 Pressure drop (See 413.8 also)
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.2 Furnaces
.3 Electric heaters
.4 Insulation
.5 Heat transfer mediums
425 Economics of heat transfer; Costs
426 Equipment for heat transfer
.1 Heat exchangers
.2 Furnaces
.3 Electric heaters
.4 Insulation
.5 Steam traps
427 Operation and control of heat transfer equipment
428 Application of heat transfer
430 Diffusional operations
430 General; Diffusion; Mass transfer
431 Distillation
.1 General principles; Fundamentals; Theories
.2 Design data
.21 Vapor pressure; Relative volatility
.22 Latent heats
.23 Laws of solutions and gases
.24 Liquid-vapor equilibrium
.25 The Phase Rule
.26 Laboratory distillations
.3 Mathematical treatment; Distillation calculations
.31 Equilibrium distillation
.32 Steam distillation
.33 Continuous fractionation
.331 Binary systems
.332 Multicomponent systems
.1 Minimum number of plates
.2 Minimum reflux ratio
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Feed plate
Plate-to-plate calculations
.333 Complex systems
.34 Batch distillation; Differential
.35 Azeotropic distillation
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.37 Molecular distillation
.4 Tower design
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.422 Vapor capacity; Entrainment; Slot opening
.423 Liquid capacity; Flooding; Tray gradient
.424 Pressure drop
.425 Plate efficiency
.43 Perforated plates
.44 Packed towers (See 432.41)
.45 Special types of columns
.46 Auxiliaries; Reboilers; Condensers
.5 Economics; Costs; Optimum reflux ratio, etc.
.6 Distillation equipment
.7 Operation and control in distillation
.8 Applications of distillation
432 Absorption
.1 General principles; Fundamentals; Theories
.2 Design data; Solubilities; Equilibria; etc.
.3 Mathematical treatment
.31 Diffusion and fluid films
.32 Absorption and chemical reaction
.33 Absorption coefficients
.34 Absorption capacity
.35 Heat balance in absorption
.36 Multicomponent absorption; Stripping
.4 Tower design (See 431.4 also)
.41 Packed towers
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.413 Flooding; Liquid loading
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.42 Spray towers
.5 Economics of absorption
.6 Absorption equipment
.7 Operation and control in absorption
.8 Applications of absorption
433 Extraction
.1 General principles; Fundamentals; Theories
.2 Design data; Solubilities
.3 Mathematical treatment; Extraction calculations
.4 Design of extractors
.5 Economics of extraction
.6 Equipment
.7 Operation
.8 Applications

Ultra-Modern Filing?

The name is "Jones" but none of the girls was really as surprised as this one appears when he was found in the "W"—for "Wolf"—drawer.

434 Adsorption
.1 General principles; Fundamentals; Theories
.2 Design data; Industrial adsorbents
.3 Mathematical treatment; Adsorption calculations
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.5 Economics; Costs
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435 Drying
.1 General principles; Fundamentals; Theories
.2 Design data
.3 Mathematical treatment; Drying calculations
.4 Dryer design
.5 Economics of drying
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.61 Spray driers
.62 Drum driers
.63 Pan driers
.64 Rotary driers
.65 Cabinet, compartment, and tunnel driers
.66 Vacuum driers
.67 Adsorption driers
.7 Operation and control in drying
.8 Applications of drying
.9 Drying of liquids and gases
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.92 Compression
.93 Refrigeration
.94 Adsorption
440 Mechanical operations
441 Storing of materials
.1 Solids storage; Bins
.2 Storage tanks
.3 Pressure vessels
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442 Movement of materials
.1 Movement of solids and containers
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.13 Trucks; Tractors; Trailers
.14 Industrial railways
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.21 Reciprocating pumps
.22 Centrifugal pumps
.23 Gear and rotary pumps
.24 Diaphragm pumps
.25 Air lifts
.26 Jet pumps
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.28 Special pumps
.3 Movement of gases
.31 Fans and blowers
.32 Reciprocating compressors
.33 Centrifugal compressors
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.4 Feeders and feeding
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443 Crushing and grinding
444 Mixing; Agitation
445 Mechanical separations
.1 Classification
.2 Sedimentation
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.4 Screening; Size separation
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.8 Settling in two-phase systems
450 Chemical operations
451 General principles; Fundamentals; Theories
452 Design data for chemical operations
453 Mathematical treatment; Chemical kinetics
454 Reactor design
455 Economics of chemical operations
456 Equipment; Reactors; Autoclaves
457 Operation and control
458 Applications
460 Miscellaneous operations
461 Evaporation
.1 General principles; Fundamentals; Theories
.2 Design data
.3 Mathematical treatment
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462 Refrigeration
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463 Humidification; Cooling towers; Spray ponds; Air conditioning
463.1 General Principles; Fundamentals; Theories
.2 Design data; Psychometric chart
.3 Mathematical treatment
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508 Alcoholic beverages (See 538 also)
509 Atomic energy
510 Bleaching compounds
512 Building materials; Cement; Concrete
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.211 Hydrocarbons
.212 Alcohols
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.215 Ethers; Esters
.216 Halogen compounds
.217 Nitrogen compounds
.218 Sulfur compounds
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.221 Benzene derivatives
.222 Naphthalene derivatives
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.23 Alicyclic compounds
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.57 Molybdenum; Beryllium
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558 Oils; Fats; Waxes
560 Paint; Varnish; Lacquer (See 568 also)
562 Paper
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.032 American Petroleum Institute
.033 Society of Automotive Engineers
.034 Coordinating Research Council
.1 Coordinating Fuel Research Committee
.11 Motor Fuels Division
.12 Aviation Fuels Division
.13 Automotive Diesel Fuels Division
.14 Non-Petroleum Fuels Division
.2 Coordinating Lubricants Research Committee
.3 Coordinating Equipment Research Committee
.035 Petroleum Division, ACS (See 061.11 also)
.04 Journals
.041 Petroleum Refiner
.042 Petroleum Engineer
.043 Oil and Gas Journal
.044 National Petroleum News
.045 Petroleum Processing
.046 World Oil (Oil Weekly)
.047 World Petroleum
.048 Petroleum Technology, AIMME
.049 Journal of the Institute of Petroleum (Brit.)
.05 Bibliographies; Abstracts
.051 UOP Abstracts
.052 Petroleum Refiner Abstracts
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564.243 Chemical equilibria
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.332 Lubricants
.333 Burner fuels
.334 Solvents
.335 Chemicals
.336 Specialties
.337 Miscellaneous
.34 Special tests
.341 ASTM tests
.342 Federal specification tests
.343 Knock rating tests
.344 Testing equipment
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.41 Occurrence of petroleum
.42 Composition of petroleum; Crude evaluation
.43 Prospecting
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.46 Transportation; Pipe lines; Tank cars; Barges
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.13 Gas reversion-Polyform process
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.21 Houdry Process
.22 Fluid catalyst process
.23 TCC process
.512 Alkylation
.1 Sulfuric acid process
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.3 Aluminum halide process
.513 Polymerization
.1 Sulfuric acid process
.2 Phosphoric acid process
.3 Copper pyrophosphate process
.514 Isomerization
.1 Isomerization of pure hydrocarbons
.2 Naphtha conversion process
.3 Isomate process
.515 Hydrogenation and dehydrogenation
.1 Shell hydrogenation process
.2 UOP hydrogenation process
.3 UOP Dehydrogenation process
.516 Aromatization
.1 Thermal
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.2 Catalytic
.21 Hydroforming process
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.517 Fischer-Tropsch synthesis
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.521 Sulfur removal
.1 Doctor treating process
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.4 Tannin solutizer process
.5 Copper chloride process
.6 Sodium polysulfide process
.7 Catalytic desulfurization
.522 Acid treating
.523 Clay treating
.53 Separation processes
.531 Distillation
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.533 Adsorption; Hypersorption process
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.4 Dewaxing
.5 Clay finishing (See 564.523 also)
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.8 Synthetic lubricants
.9 Grease compounding
.543 Burner fuels
.544 Solvents
.1 Aliphatic
.2 Aromatic
.3 Special
.545 Chemicals from petroleum
.546 Specialties
.55 Special refining problems; Waste disposal; Emulsion control, etc.
.6 Products; Utilization; Applications
.60 General
.601 Availability and demand of petroleum products
.602 Specifications of petroleum products
.61 Engine fuels
.611 Spark-ignition fuels
.1 Automotive fuels
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.12 Detonation
.121 Knock ratings of pure hydrocarbons
.122 Knock ratings of stocks and blends
.123 Laboratory knock rating and correlation
.124 Full scale knock rating and correlation
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.14 Deposits; Engine wear
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.16 Operating variables of automative engines
.17 Blending of automotive fuels
.2 Aviation fuels
.21 Inspections of aviation fuels
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.221 Knock ratings of pure hydrocarbons
.222 Knock ratings of stocks and blends
.223 Laboratory knock rating and correlation
.224 Full-scale knock rating and correlation
.23 Volatility
.24 Deposits; Engine wear
.25 Storage stability
.26 Operating variables of aviation engines
.27 Blending of aviation fuels
.28 Safety fuel
.29 Pre-ignition
.3 Tractor fuels
.4 Marine fuels
.612 Diesel engine fuels
.1 Inspections of diesel fuels
.2 Ignition quality
.21 Cetane number
.22 Cold starting
.23 Additives
.3 Volatility
.4 Deposits; Engine wear
.5 Storage stability
.6 Operating variables of diesel engines
.7 Blending of diesel fuels
.613 Gas turbine and jet fuels
.1 Inspections of gas turbine fuels
.2 Combustion and burning quality
.3 Deposits
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.614 Rocket fuels
.62 Lubricants
.621 Automotive oils
.1 Engine oils
.2 Gear oils
.3 Miscellaneous oils
.622 Aviation oils
.1 Engine oils
.2 Gear oils
.3 Miscellaneous oils
.623 Marine oils
.624 Railroad oils
.625 Industrial oils
.1 Engine oils
.2 Gear oils
.3 Compressor oils
.4 Cylinder oils
.5 Machine oils
.6 Cutting and grinding oils
.7 Miscellaneous oils

564.626 Synthetic lubricants
.627 Greases
.63 Burner fuels
.631 Domestic fuels
.1 Gases
.2 Kerosine and No. 1 fueloil
.3 Furnace oil (No. 2 fueloil)
.632 Industrial fuels
.1 Distillate; Nos. 3, 4, and 5 fueloils
.2 Residual; No. 6 fueloil Bunker C
.64 Solvents
.641 Dry cleaners
.642 Paint, varnish and lacquer solvents
.643 Rubber solvents
.644 Plastic solvents
.65 Chemicals from petroleum
.66 Specialties
.661 Paint
.662 Resins; Plasticisers; Elastomers
.663 Electrical insulating oils
.664 Waxes; Petrolatums
.665 Process oils
.666 Tar; Asphalt
.7 Economics of petroleum industry
566 Photography
568 Pigments (See 560 also)
570 Plastics
572 Power generation; Mechanical transmission
574 Resins; Gums
576 Rubber
578 Sanitation; Sewage disposal
580 Soap
582 Solvents
584 Textiles; Synthetic fibers
586 Waste disposal
588 Water
590 Wood; Cellulose

600 Economics and management
600 General
601 Organization of chemists and engineers
602 Psychology; Leadership
603 Composition; Report writing
604 Public speaking; Presentation of papers
605 Conferences
606 Office economy
610 Administration; Top management planning
620 Research and development
621 Fundamental research
622 Industrial research (laboratory)
623 Pilot plant development
624 Process design
625 Technical service
626 Patents; Inventions (See 044 also)
630 Economic evaluation
631 Market analysis
.1 Production and consumption statistics
.2 Chemical prices
.3 Geographical factors
632 Plant investment cost estimation
.1 Unit operation equipment (May be classified similar to 400 series)
.2 Instruments
.3 Buildings
.31 Foundations
.32 Buildings
.33 Structures; Supports; Platforms
.4 Excavation and grading
.41 Excavation
.42 Roads
.43 Grading
.44 Sewers
.5 Miscellaneous materials
.51 Insulation
.52 Paint
.53 Wiring
.54 Lighting
.55 Heating
.56 Ventilating
.6 Freight costs
.7 Labor costs
.8 Taxes; Insurance
.9 Investment cost as a function of of plant capacity
633 Manufacturing cost estimation
.1 Direct costs
.11 Chemicals and materials
.12 Labor and supervision
.13 Utilities
.131 Steam
.132 Water
.133 Electricity
.134 Fuels
.135 Compressed air
.14 Maintenance and materials
.15 Royalties
.16 Laboratory costs
.17 Miscellaneous direct costs (supplies, etc.)
.2 Indirect costs
.21 Taxes
.22 Insurance
.23 Depreciation
.24 Administration and overhead
.25 Capital charges
634 Economics of plant location
635 Project analysis
640 Organization
650 Personnel management; Wages; Labor relations
660 Production management
661 Production organization
662 Operation
663 Control
664 Maintenance
665 Safety
670 Finance
680 Sales
690 Miscellaneous economic and management factors

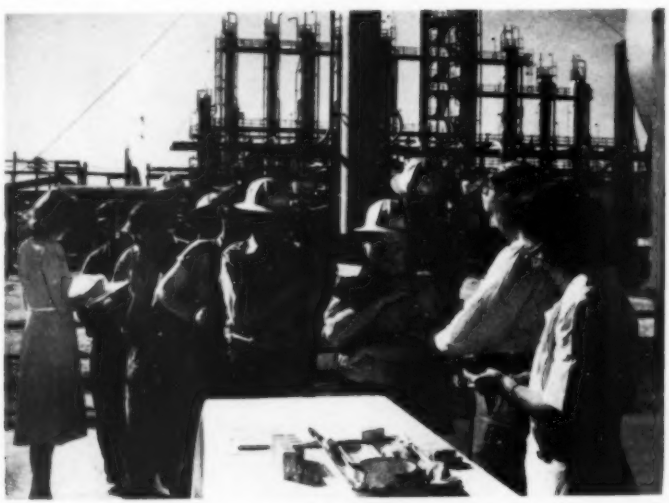
700 Other branches of engineering
710 Civil engineering
720 Mechanical engineering
730 Electrical engineering

800 Experience

900 Miscellaneous

* * *

The Gulf Fights Influenza



A test program of influenza inoculations at the Gulf Oil Company's Port Arthur, Texas, refinery has reduced flu cases among the personnel by one-third. The prevention project is thought to be one of the most extensive of its kind undertaken in the industry. More than 68 percent of the workers have volunteered to take the injections, under the direction of Dr. James W. Long, head of the refinery medical department and mayor of Port Arthur (second from right in photo above).

The number of cases in the first five months of 1948 was 139 as against 262 for the same period in 1947. For the same period in 1948 only 1590 scheduled working days were lost as against 2528 for 1947 in the same months. The frequency rate per 1000 employes was 21.47 in the vaccinated group and 33.75 in the unvaccinated.

Inoculations are given at lunch hours, shift changes and at various locations about the plant. The entire program was originated and is being carried out by the medical department. All expense is absorbed by the refinery management.

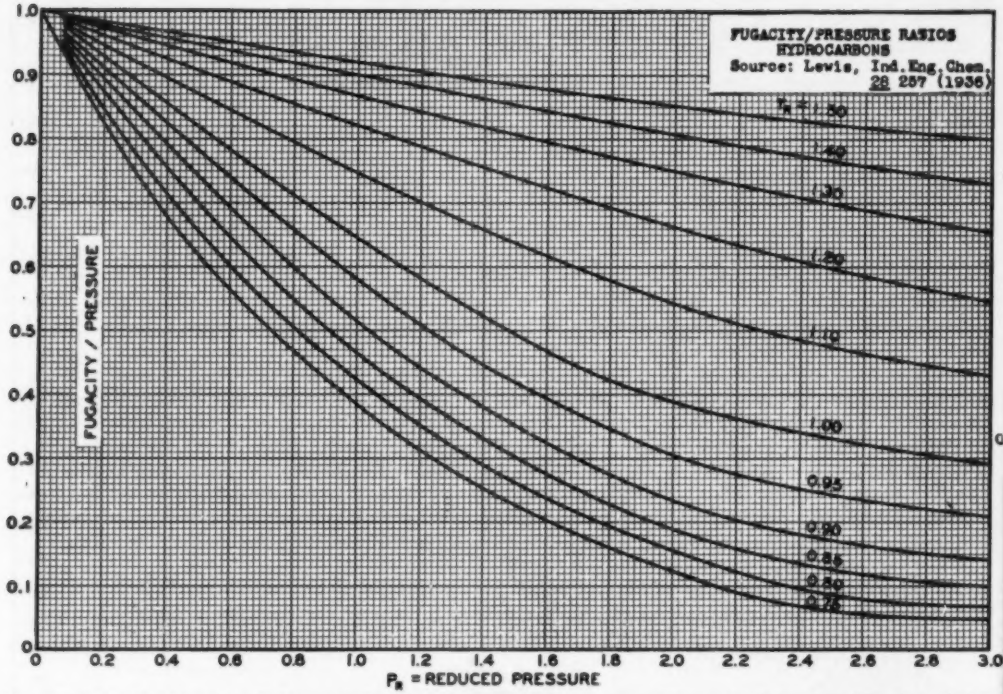


Figure 62. Activity Coefficient (Fugacity/Pressure Ratio) a Function of Reduced Temperature and Pressure for Hydrocarbons. This chart, which first appeared in a 1934 article by Lewis and Kay,[10] was developed from generalized PVT data correlations plus some experimental data on ideal mixtures.

Applications of Thermodynamics To Hydrocarbon Processing

PART XIX — Vapor-Liquid Equilibria in Ideal Mixtures

WAYNE C. EDMISTER
Professor of Chemical Engineering, Carnegie Institute of Technology, Pittsburgh

***FOR MIXTURES** of a finite number of well defined components, such as the lower boiling hydrocarbons, vapor-liquid phase equilibria conditions are computed by means of equilibrium ratios, $K = y/x$, for each component. For ideal mixtures these vapor-liquid distribution ratios are functions of temperature and pressure for each component. These "ideal" equilibrium ratios can be computed from generalized thermodynamic properties. This procedure is outlined and illustrated in this installment. The equations derived and presented in this installment include some of the rigorous and general ones that apply to both "non-ideal" and "ideal" mixtures.*

HYDROCARBON processing operations almost always involve co-existing vapor and liquid phases of multicomponent hydrocarbon mixtures. These co-existing phases are not always at equilibrium but are always approaching equilibrium and are frequently very near to equilibrium. In process design work it is customary to assume that equilibrium has been reached and to make calculations based on this phase situation. Thus, it is important to be able to estimate equilibrium conditions and compositions for vapor-liquid two phase systems.

Because of the multicomponent nature of hydrocarbon systems, encountered in process design work, it is necessary to have rapid methods of making these equilibrium calculations. Various types of plots, nomographs and tabulations, giving theoretical and empirical vapor-liquid phase equilibria information, are being used by process engineers. Many of these have been published but some have not.

In reviewing this background in the current installment, the theory as well as the simplifying assumptions and the methods of presenting the results in the form of practical charts will be discussed.

For convenience, hydrocarbon mixtures may be classified as follows: a) mixtures of limited number of easily

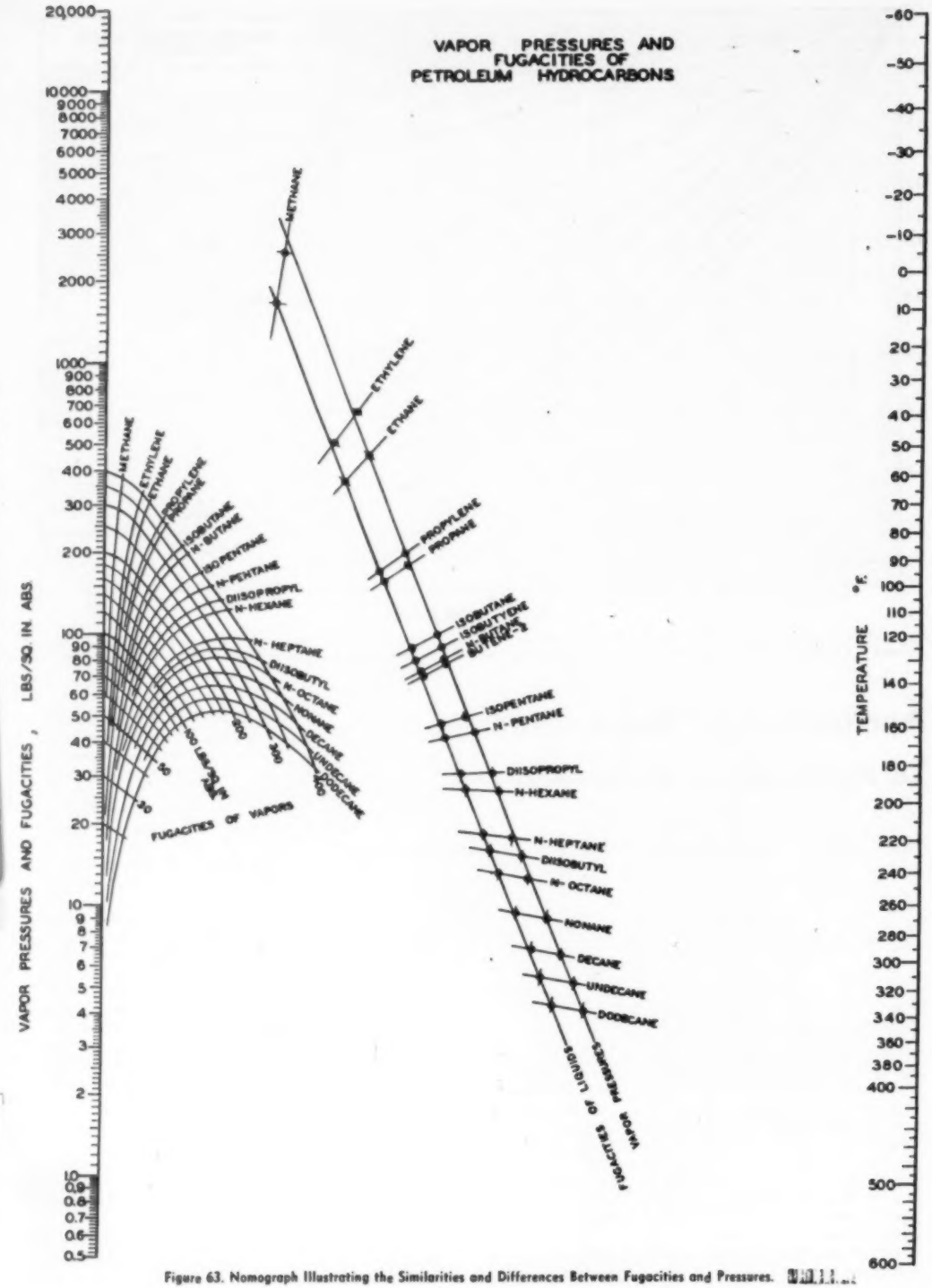


Figure 63. Nomograph Illustrating the Similarities and Differences Between Fugacities and Pressures.

identifiable components, each appearing in an appreciable amount; b) mixtures of substantially infinite number of practically unidentifiable components, which appear in infinitesmally small concentrations; and c) mixtures containing both types of components, i.e. type *a* in the lower boiling range and type *b* in the upper boiling range. True boiling point distillations yield plateaus for type *a* mixture and smooth curves for type *b* mixture. Type *c* true boiling point will have plateaus in the lower part but will be smooth in the higher temperature range.

Vapor-liquid phase equilibrium calculations for mixtures of the first type are made by a *component* method using an equilibrium ratio, for each component. Empirical methods are used in making vapor-liquid equilibrium calculations for type *b* mixture. For type *c* it is customary to use the same component method used for type *a* by dividing the higher boiling portion of the TBP curve into hypothetical components.

The empirical methods for petroleum fractions, i.e. type *b*, will be taken up in a later installment.

Deviations from Ideality

There are three deviations from ideality involved in vapor-liquid phase equilibrium; namely a) the deviation from the perfect gas law ($PV = RT$) that is exhibited by all real gases; b) the deviation of the vapor phase from an ideal gas mixture of additive volumes; and c) the deviation of the liquid phase from an ideal liquid solution of additive volumes.

Deviations from the perfect gas law is principally a function of the temperature and pressure conditions for each hydrocarbon. The deviations from ideal gas mixtures and ideal liquid solutions is largely dependent upon the chemical differences, attractions, etc., between the different components but also upon temperature and pressure to a lesser degree.

Following are five cases of deviation from ideality that are most frequently encountered.

Phase Deviation	VAPOR		Liquid Solution
	Gas Law	Gas Mixture	
Case I	Perfect	Ideal	Ideal
Case II	Perfect	Ideal	Non-ideal
Case III	Real	Ideal	Ideal
Case IV	Real	Ideal	Non-ideal
Case V	Real	Non-ideal	Non-ideal

Cases I and III will be discussed in this installment. Case III is the basis for most of the moderate temperature and pressure K values used in hydrocarbon vapor-liquid equilibrium calculations. Case II frequently applies to aqueous solutions at low pressures. For hydrocarbon systems at high pressures and low temperatures, Cases IV and V apply.

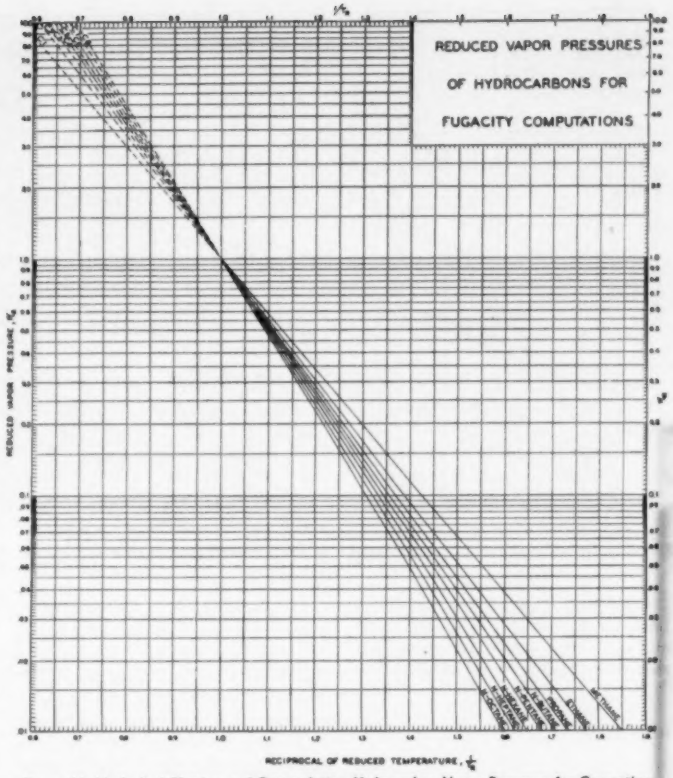


Figure 64. Method of Plotting and Extrapolating Hydrocarbon Vapor Pressures for Computing Ideal Liquid Fugacities.

The effect of deviations from the perfect gas laws on the vapor-liquid equilibrium ratios can be computed from generalzied correlations. Deviations from ideal solutions, on the other hand, must be determined experimentally and/or calculated from a precise equation of state for the mixtures in question.

Ideal Systems

The simplest method of estimating vapor-liquid equilibrium is by use of the vapor pressures of the components and the total pressure of the system, employing Raoult's and Dalton's laws. This is Case I of the above five cases and involves ideal behavior in both phases.

Dalton's law states that the partial pressure of an individual component in a gaseous mixture is equal to the product of the total pressure and the mole fraction of that individual component. Expressed mathematically

$$p = yP \tag{331}$$

Where:

p = partial pressure
P = total pressure
y = mole fraction in vapor phase

Raoult's law states that the partial vapor pressure exerted by a component in a liquid mixture is equal to the product of the mole fraction of the component in the mixture and its vapor pressure (i.e. pressure exerted by the component in a pure state) at the same temperature. Expressed mathematically

$$p = x\pi \tag{332}$$

Where:

p = partial pressure
π = vapor pressure
x = mole fraction in liquid phase

Henry's law states that a liquid solvent absorbs a mass of gas that is proportional to the pressure of the gas. Expressed mathematically

$$p = HC \tag{333}$$

Where:

p = partial pressure
H = Henry's law constant
C = lb.mol./cu.ft. of gas absorbed

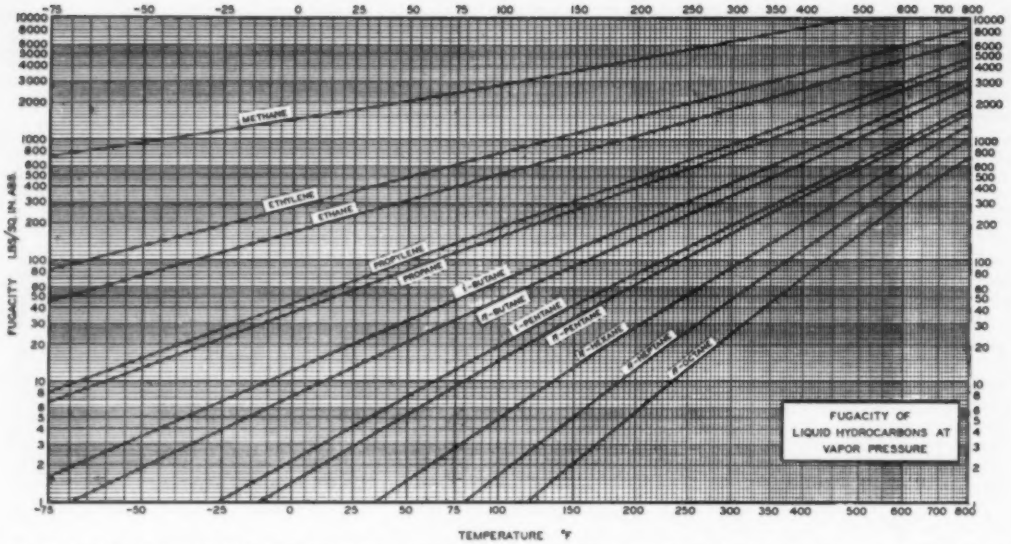


Figure 65. Fugacities of Pure Liquid Hydrocarbons at Vapor Pressure. This chart is derived from Figure 62, using vapor pressure and critical data. This chart illustrates one method of plotting fugacities.

Combining Dalton's and Raoult's laws, as expressed by equations 331 and 332, gives the following equilibrium relationship for ideal systems[7]

$$p = yP = x\varpi$$

from which

$$\frac{y}{x} = \frac{\varpi}{P} = K \qquad (334)$$

Where:

K = y/x, the vapor-liquid equilibrium ratio, by definition.

Combining Dalton's and Henry's laws, as expressed by equations 331 and 333, and replacing C by its equivalent

$$C = \frac{\rho}{M}x$$

Where:

ρ = density of solvent, lbs./cu. ft.
M = molecular weight of solvent
x = mole fraction of solute in solvent.

gives the following relationship for ideal systems

$$p = yP = HC = H\frac{\rho}{M}x,$$

from which

$$\frac{y}{x} = \frac{H}{P}\left(\frac{\rho}{M}\right) = K \qquad (335)$$

Where:

K = the vapor-liquid equilibrium ratio, defined above.

Equation 335 is of interest because it shows the relation between the equilibrium ratio, K, and the Henry's law constant, H.

In this connection it should be pointed out that the technical literature contains two different definitions of the Henry's law constant. Sherwood[20] uses the reciprocal of that given in equation 333. In Perry's "Chemical Engineer's Handbook" both are given. Badger and McCabe use the definition of the Henry's law constant given in equation 333, which is the way Henry originally proposed it in 1802.

Equations 334 and 335 are of historic interest because they are the vapor-liquid relationships used by most process design engineers before the "fugacity" era introduced by Lewis and Randall[11] in the 1920's. Before the extensive use of high pressures in the petroleum industry these relationships could be used with the reasonable accuracy for vapor-liquid phase equilibria calculations.

During those years before the widespread use of fugacity ratios, a vapor pressure chart was all that was necessary for the calculation of vapor-liquid phase equilibrium. Natural gasoline plants, vapor recovery units, and distillation equipment were all designed by the use of vapor pressures. Engineering and operating offices all had their own *private* vapor pressure charts. The Cox chart that came out in 1923 was the type most widely used. A chart of this type was presented as Figure 16 in Part VIII of this series (PETROLEUM REFINER, February, 1948). The Coates-Brown vapor pressure chart that came out in 1928 was also widely used. However, the Cox type chart was more convenient when it came to extrapolating above the critical as was necessary for the lighter hydrocarbons.

Fugacity Relationships

In 1932 G. G. Brown and his associates at The University of Michigan[19, 21] and W. K. Lewis and his associates at Massachusetts Institute of Technology[6, 7, 8, 9, 10] developed and published fugacity equilibrium ratios for the hydrocarbons. These important design tools were based on the Lewis and Randall[11] fugacity rule (see below) and were developed from generalized PVT correlations. Thus, two teams of investigators did the same badly needed job simultaneously. Graphs of equilibrium ratios from both sources were soon in wide use throughout the hydrocarbon processing industries.

Fugacity was defined for pure components in Part XI (PR, May, 1948) as a replacement for pressure in the equation for the isothermal change in free energy. Reference is made to Equations 242, 243 and 244, which show how the fugacity is evaluated for non-perfect gases. For mixtures in vapor and liquid equilibrium, the fugacities of the different components must be evaluated in such a way as to take into account the deviations from ideal gas mixture and from ideal liquid solutions, as well as from the perfect gas law.

The derivation of these equations involved formulating the changes in the partial free energies (i.e. the chemical potentials) in terms of fugacities with properly established reference states for each phase. At equilibrium the chemical potential of component "i" in the vapor phase is equal to the chemical potential of component "i" in the liquid phase. This must be true for all components in the mixture. This condition for equilibrium is adequately proven in texts on thermodynamics.[4, 5, 11] These texts plus notes from articles and discussions with many authorities, including M. Benedict,[1] are the sources of the following theoretical equations.

Expressed in terms of fugacities the condition for equilibrium is

$$\overline{f_i}^V = \overline{f_i}^L \qquad (336)$$

Where:

$\overline{f_i}^V$ = fugacity of component "i" in the vapor phase,

$\overline{f_i}^L$ = fugacity of component "i" in the liquid phase

The fugacity is thus defined in such a way that it is a quantitative measure of the escaping tendency of a gas from a solution, or of component "i" from a mixture.

Methods of estimating the fugacities in the vapor and liquid phases are required before equation 336 can be used. Some of the fundamental relationships and equations will be given first and then the simplification of ideal mixtures will be imposed and the relations used by Brown et al. and Lewis et al. will be developed.

The definition of fugacity, f, was given by equation 242 as follows:

$$F_2 - F_1 = RT \ln \frac{f_2}{f_1} = \int_{P_1}^{P_2} V dP \qquad (242)$$

In terms of the volume residual,

$$\alpha = \frac{RT}{P} - V$$

$$F_2 - F_1 = RT \ln \frac{f_2}{f_1} =$$

$$RT \ln \frac{P_2}{P_1} - \int_{P_1}^{P_2} \alpha dP \qquad (243)$$

Equations 242 and 243 are general expressions based on the definition of fugacity and the relation for the isothermal effect of pressure on the free energy, all for a single component homogeneous fluid.

From the definition of fugacity as given by equations 242 and 243, we may write

$$\overline{F}_i - F_i = RT \ln \frac{\overline{f_i}}{f_i} \qquad (337)$$

Where: the bars above F and f indicate values in mixture.

$\overline{F}_i$ is the partial molal free energy or the chemical potential.

If equation 337 is applied to a vapor mixture and the pure component reference state is taken as the pressure at unit fugacity, $f_i = 1$ and

$$\overline{F}_i - F_i^\circ = RT \ln \overline{f_i}^V \qquad (338)$$

For mixtures of ideal gases the fugacity of component "i" is equal to its partial pressure, $y_i P$. This is true at the low standard reference pressure. For these conditions

$$\overline{F}_i^\circ - F_i^\circ = RT \ln y_i P \qquad (339)$$

Combining equations 338 and 339 gives

$$\overline{F}_i - \overline{F}_i^\circ = RT \ln \frac{\overline{f_i}^V}{y_i P} \qquad (340)$$

The ratio $\overline{f_i}^V / y_i P$ approaches unity as pressure approaches zero. This ratio may be evaluated from observed PVT data on the pure component and the mixture by the following equation,

$$\ln \frac{\overline{f}^V}{y_i P} = -\frac{1}{RT} \int_0^P \overline{\alpha}_i dP \qquad (341)$$

Where:

$\overline{\alpha}_i$ = partial residual volume $= \overline{V}_i - \frac{RT}{P}$;

$\overline{f}^V / y_i P$ = activity coefficient of component "i" in the vapor phase.

For the liquid phase the reference state will be the pure liquid component in an ideal liquid mixture. In this case $\overline{f_i}^L = f_i^L$ for the pure liquid and $F_i = \overline{F}_i^\circ$. For an ideal liquid mixture $\overline{f_i}^L = x_i f_i^L$. For a non-ideal liquid mixture $\overline{f_i}^L = x_i f_i^L \gamma_i^L$, where γ_i^L is a nonideality correction factor thus defined.

For these conditions equation 337 becomes for a liquid mixture

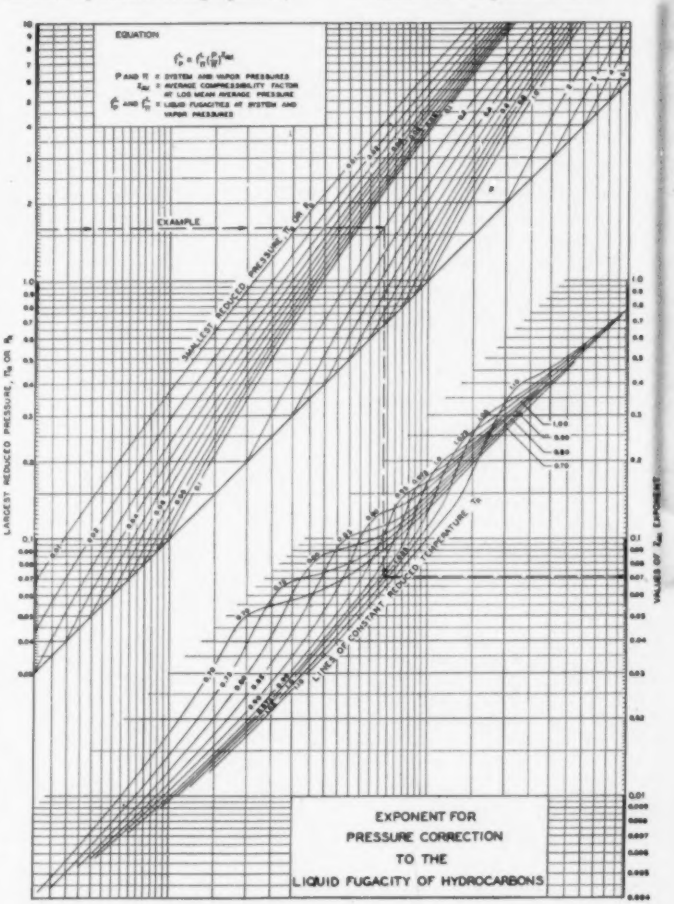


Figure 66. Chart for Obtaining Exponent to Correct Ideal Liquid Fugacity at Vapor Pressure to the Ideal Liquid Fugacity at the System Pressure.

$$\overline{F}_i - \overline{F}_i^{\circ} = RT \ln x_i \gamma_i^L \quad (342)$$

Where:

$\gamma_i^L = \dfrac{\overline{f}_i^L}{x_i f_i^L}$ = activity coefficient of component "i" in the liquid phase;

$x_i \gamma_i^L = a_i$ = activity of component "i" in liquid.

The term $x_i \gamma_i^L$, the liquid activity, becomes x_i, the mol fraction of component "i", for ideal liquid mixtures.

The activity coefficient for non-ideal liquid mixtures

$$\gamma_i^L = \frac{a_i}{x_i} = \frac{\overline{f}_i^L}{x_i f_i^L} \quad (343)$$

may be evaluated from partial molal volumes in the same manner used for the vapor phase, for which the equation is

$$\ln \gamma_i^L = \frac{1}{RT} \int_o^P (\overline{V}_i - V_i) dP \quad (344)$$

Where:

$\overline{V}_i$ = partial molal volume of component "i" in mixture

V_i = volume of component "i" in pure state.

When $\overline{V}_i = V_i$, as in Amagat's law of ideal solutions, the value of $\gamma_i^L = 1.0$.

For this condition

$$\overline{f}_i^L = x_i f_i^L \quad (345)$$

which is known as the "Lewis and Randall rule." In similar fashion

$$\overline{f}_i^V = y_i f_i^V \quad (346)$$

Equations 345 and 346 are used to calculate ideal fugacities and the vapor-liquid ratios that follow therefrom.

Fugacities for Ideal Mixtures

Vapor-liquid phase equilibrium relationships for ideal mixtures (i.e. ideal vapor and ideal liquid) may be obtained by combining equations 336, 345 and 346 giving

$$\overline{f}_i^V = y_i f_i^V = \overline{f}_i^L = x_i f_i^L$$

from which it follows that

$$\frac{y_i}{x_i} = \frac{f_i^L}{f_i^V} \quad (347)$$

The values of f_i^L and f_i^V may be evaluated from generalized correlations as will be shown. In subsequent equations the subscript "i" will be omitted for simplicity, it being understood that the fugacity equation must be applied to each and every component in the mixture.

The fugacity of a pure component in the vapor phase may be evaluated from the PVT data by

$$\ln \frac{f}{P} = -\frac{1}{RT} \int_o^P \alpha dP \quad (244)$$

The volume residual, α, is given as a function of reduced pressure and reduced temperature in Figure 20 (Part IX, PR, March, 1948). The f/P ratio may also be evaluated from compressibility factors by a similar equation.

Gas Fugacities

Fugacity/pressure ratios have been calculated for gases and correlated as a function of T_r and P_r by several investigators.[6,8,9,10,15,19] Vapor fugacities may be found by solving equation 244A (Part XI). This was done and the result tabulated in Table 20 of Part XII. Figure 62 is an example of these generalized f/P correlations. Figure 62, which first appeared in 1934 in an article by Lewis & Kay[10] was developed from PVT data and experimental vapor-liquid equilibrium data, experimental data being necessary to extend the less-than-unity isotherms to high reduced pressures than was possible by means of PVT data alone.

By means of PVT data alone the values of f/P for these less-than-unity isotherms could be computed only up to the vapor pressure. Many published f/P charts show these isotherms cut off at these lower pressures. Lewis and Kay[10] indicated this limit of PVT f/P values by a dashed line on the first version of Figure 62. This dashed line crossed the T_r lines at the following pressures

T_r Line	P_r Value at Limit of PVT Data f/P Values
0.75	0.12
0.80	0.20
0.85	0.32
0.90	0.47
0.95	0.70

In a later publication[7] this boundry line was omitted. After many years of use, Figure 62 and the K values derived therefrom have become widely accepted as theoretical correlations. The fact that some experimental data was necessary in the development to extend these less-than-unity isotherms has been overlooked by some and forgotten by others. These less-than-unity isotherms are applied to components in both liquid and vapor phases.

Before taking up the applications of Figure 62, a comparison will be made between f/P values from Table 20 (Part XII), Figure 62 and from another source.[15] In computing f/P values from the k_i ln f/P values given in Table 20, a value of —1.38 is used for k_i. The following comparison shows good agreement between these three independently determined values of f/P.

T_r	P_r	Table 20	Figure 62	Newton[15]
1.0	1.0	0.655	0.645	0.62
	2.0	0.387	0.39	0.385
	3.0	0.299	0.29	0.290
1.1	1.0	0.755	0.750	0.740
	2.0	0.545	0.540	0.56
	3.0	0.431	0.429	0.435
1.2	1.0	0.81	0.82	0.816
	2.0	0.56	0.56	0.67
	3.0	0.55	0.545	0.56

Of these three f/P compilations, only Figure 62 has been extended to higher pressures than the vapor pressures for the less-than-unity reduced temperatures. Newton[15] went to higher temperatures ($T_r = 35.0$) and pressures ($P_r = 100$) than any other f/P correlations. Newton also proposed applying this generalized f/P correlation to helium and hydrogen by computing reduced conditions with corrected critical conditions obtained by adding 8° K and 8 atm. to the actual critical values.

There have been so many contributions to the technical literature on the subject of activity coefficients (i.e. fugacity/pressure ratio) of gases that space does not permit discussing them. Examples are the two papers by Marion & Turnbull,[12,13] wherein activity coefficients of gases were computed from the Beattie-Bridgeman equation of state and where activity coefficients were used in the development of a generalized equation of state. Recently, published tabulation of thermodynamic properties for hydrocarbons have included f/P values for the saturated and superheated phases.

Activity coefficients have other applications than vapor-liquid equilibrium, namely, reaction equilibrium and product distribution calculations. In many cases, reactants and products are in the gas phase so gaseous activity coefficients may be used to compute effects of deviation from perfect gas laws. This will be discussed in more detail in a later installment.

Estimation of Fugacities

The estimation of fugacities from Figure 62 for homogeneous and hetrogeneous equilibria is a straight forward computation. In using Figure 62, it should be remembered that it is a generalized correlation and as such is an approximation. A more important limitation is the assumption of ideal mixtures and solutions necessary in the application of pure component fugacities to mixtures.

The use of Figure 62 in the evaluation of vapor fugacities is obvious. Knowing the pressure and temperature conditions of the vapor and its critical temperature and pressure, reduced conditions are computed, value of f/P is found from Figure 62 and f^V is found by multiplying by the pressure.

An example will illustrate the application of Figure 62. Find the fugacity

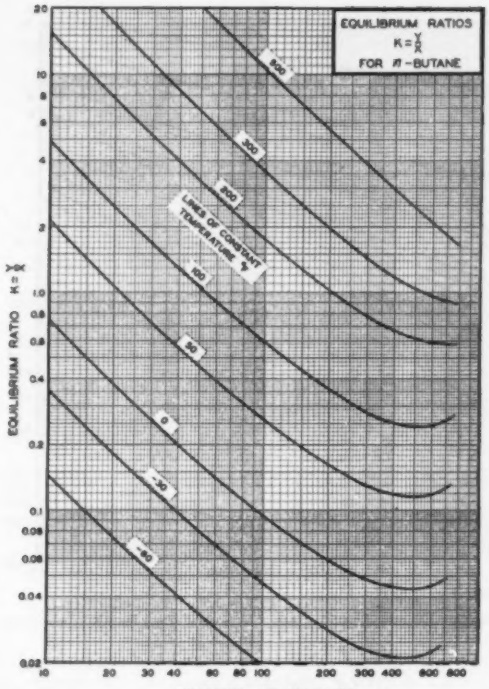


Figure 67. M.I.T. Ideal Fugacity Vapor-Liquid Equilibrium Ratios for n-Butane, Illustrating One Method of Plotting K = y/x Ratios.

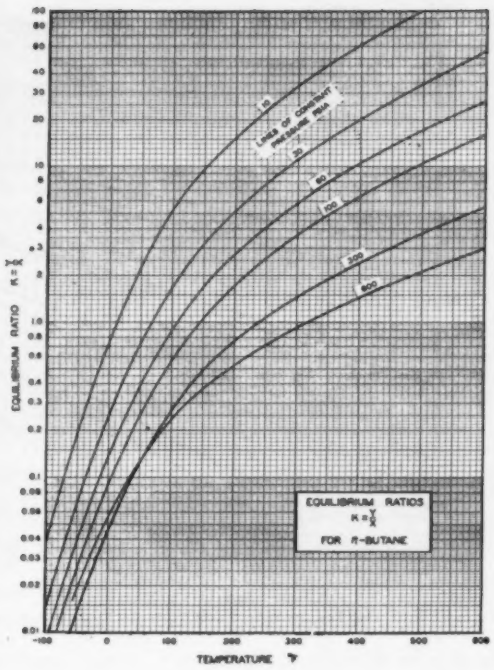


Figure 68. M.I.T. Ideal Fugacity Vapor-Liquid Equilibrium Ratios for n-Butane, Illustrating One Method of Plotting K = y/x Ratios.

of ethane vapor at 100° F. and 300 psia.

$$T_r = \frac{100 + 460}{90 + 460} = 1.016$$

$$P_r = \frac{300}{709} = 0.424$$

From Fig. 62, f/P = 0.86

$f^v = (0.87)\ (300) = 258$ psia.

Figure 62 may be used to calculate the fugacity of liquids at their vapor pressure by using the fact that the fugacity of a pure component as a saturated liquid is equal to the fugacity of the same component as a saturated vapor at the same temperature and pressure. This follows from the fact that the saturated vapor and liquid phases of a pure component are in equilibrium plus the fact that we are now talking about ideal mixtures, as defined by equations 345 and 346. Expresses mathematically,

$$f_{\pi}^{L} = f_{\pi}^{V} \qquad (348)$$

Where:

f_{π}^{L} = the fugacity of component as a liquid at the vapor pressure,

f_{π}^{V} = the fugacity of component as a vapor at the vapor pressure.

From equation 348, it can be seen that the fugacity of a saturated liquid can be estimated from Figure 62 by finding the corresponding vapor fugacity. This is the procedure used by many authors in the past in applying Figure 62 to the computation of ideal fugacity vapor-liquid equilibrium ratios.

Figure 63 is a nomograph of vapor pressures and fugacities of hydrocarbons. This nomograph is for illustration purposes only. It is not accurate enough for precise design calculations. Figure 63 was prepared from vapor pressures and the values of f/P given in Figure 62.

Vapor pressures are represented by the diagonal row of points so identified. A straight edge thru the proper point on the "vapor pressure" row and the temperature on the temperature scale (right side) gives the vapor pressure on the vapor pressure scale (left side). For example, the vapor pressure of ethane at 100° F. is found to be 780 psia.

Liquid fugacities at the vapor pressure are found in the same manner by using the row of points marked "fugacities of liquids." For example, the fugacity of ethane at 100° F. and its vapor pressure of 780 psia. is found to be 540 psia. This difference, i.e. 540 vs. 780 represents the deviation from the perfect gas law at these conditions.

Vapor fugacities are found for the hydrocarbons by using the grid identified as "fugacities of vapors" with the two main parellel and vertical scales for the nomograph, i.e. the temperature and pressure scales. This reading involves locating the proper point in the grid and setting a straight edge thru this and the temperature and reading the fugacity. For example, the fugacity of ethane vapor at 100° F. and 300 psia. is found to be 255 psia. This is in good agreement with the 258 value of the fugacity found from Figure 62 above. The difference between 300 and 255 represents the deviation of ethane from the perfect gas law at these conditions.

Liquid Fugacities

The use of Figure 62 for estimating liquid fugacities requires smooth consistent vapor pressures. Since reduced conditions are used in the calculations of K = y/x values made from Figure 62, it is logical that vapor pressures be plotted and smoothed in these units. Figure 64 is such an auxiliary plot, illustrating how this step might be

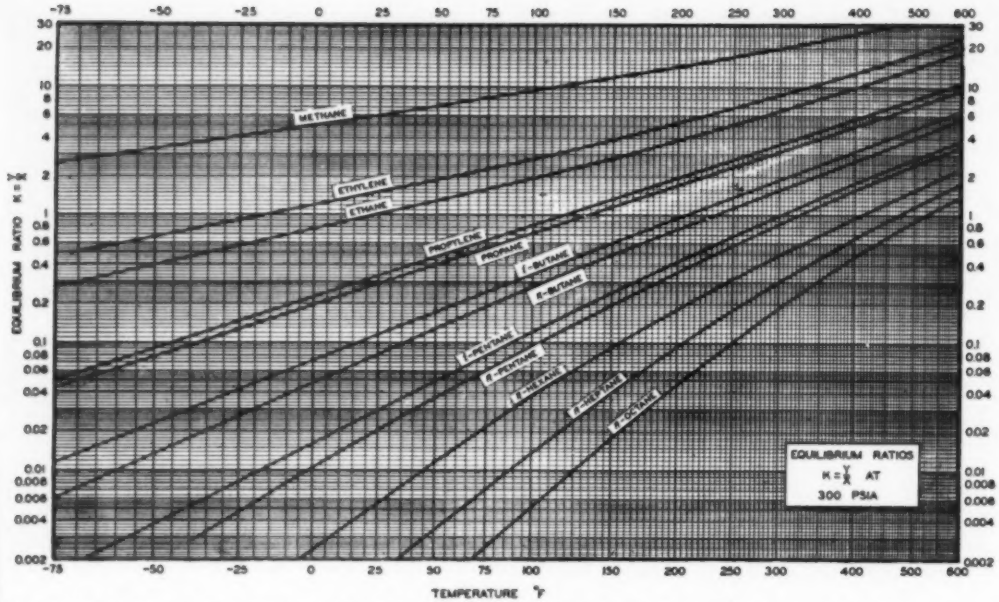


Figure 69. M.I.T. Ideal Fugacity Vapor-Liquid Equilibrium Ratios for Hydrocarbons at 300 psia. This illustrates one method of plotting K = y/x ratios.

made in the development of hydrocarbon K charts. It will be noted that the scales of Figure 64 are similar to the Cox vapor pressure plot, i.e. Figure 16 (Part VIII), except that reduced conditions are used. This gives a plot of the logarithm of reduced vapor pressure (i.e. $\pi_r = \pi/P_c$) vs. reciprocal of reduced temperature. This technique was used in the preparation of the ideal K charts and was discussed by Sherwood.[20]

From Figures 62 and 64 and the critical constants in Table 13 (Part VII) the fugacities of liquid hydrocarbons at their vapor pressure were computed and plotted in Figure 65, which is included to illustrate another of the intermediate steps in the development of K-charts. The customary method of compiling and correlating ideal fugacity data to combine the liquid and vapor fugacities to obtain the equilibrium ratio which are plotted as functions of temperature and pressure for each hydrocarbon. This is satisfactory for ideal vapor mixtures and liquid solutions. Where the mixtures are non-ideal it is best to correlate the fugacities of each phase separately. From this standpoint, Figure 65 is particularly interesting because it is one form of such a correlation for the liquid. The fugacities of components in non-ideal liquid solutions requires experimental data for evaluation.

Liquid fugacities obtained from Figure 62 by the method described above are at the vapor pressure at the given temperature. The system pressure is always higher or lower than the vapor pressures of most of the components. This difference in pressure should be taken into consideration in computing the liquid fugacities of these components. This is done by applying the basic equation for the fugacity between the vapor pressure and the system pressure, as follows:

$$RT \ln \frac{f_P^L}{f_\pi^L} = \int_\pi^P V dP \quad (349)$$

Where:

f_P^L = liquid fugacity of component at system pressure,

f_π^L = liquid fugacity of component at vapor pressure.

Replacing V by ZRT/P and integrating with an average compressibility factor gives

$$\ln \frac{f_P^L}{f_\pi^L} = Z_{av} \ln \frac{P}{\pi}$$

which may be written

$$\frac{f_P^L}{f_\pi^L} = \left(\frac{P}{\pi}\right)^{Z_{av}} \quad (350)$$

Equation 350 is a means of correcting the liquid fugacity from the vapor pressure to the system pressure. The exponent Z_{av} may be found from Figure 66, where it is given as a function of reduced temperature and log mean average reduced pressure (i.e. log mean average of reduced vapor and system pressures). The dashed line example shows how Figure 66 is read.

Figure 66 was prepared by combining the liquid phase compressibility factors with the graph for evaluating the log mean average, these two being the lower and upper parts of Figure 66, respectively. The lower part of Figure 66 is similar to the lower part of Figure 44 in Part XIV (PR, December, 1948).

As an example in the use of Figure 66, the pressure correction to the fugacity of liquid ethane will be found. The system conditions are 100° F. and 300 psia. From above $T_r = 1.035$.

From Figures 16 and 63 the vapor pressure of ethane is found to be $\pi = 780$ psia.

$$\pi_r = \frac{780}{709} = 1.10$$

$$P_r = \frac{300}{709} = 0.424$$

From Figure 65 $f_\pi^L = 520$ psia
From Figure 66, $Z_{av} = 0.073$
From Equation 350

$$f_P^L = 520 \left(\frac{300}{780}\right)^{0.073} = 484 \text{ psia}$$

For this example, the pressure correction to liquid fugacity is 7 percent and significant. If the pressure had been higher than the vapor pressure, the correction would have been in the opposite direction.

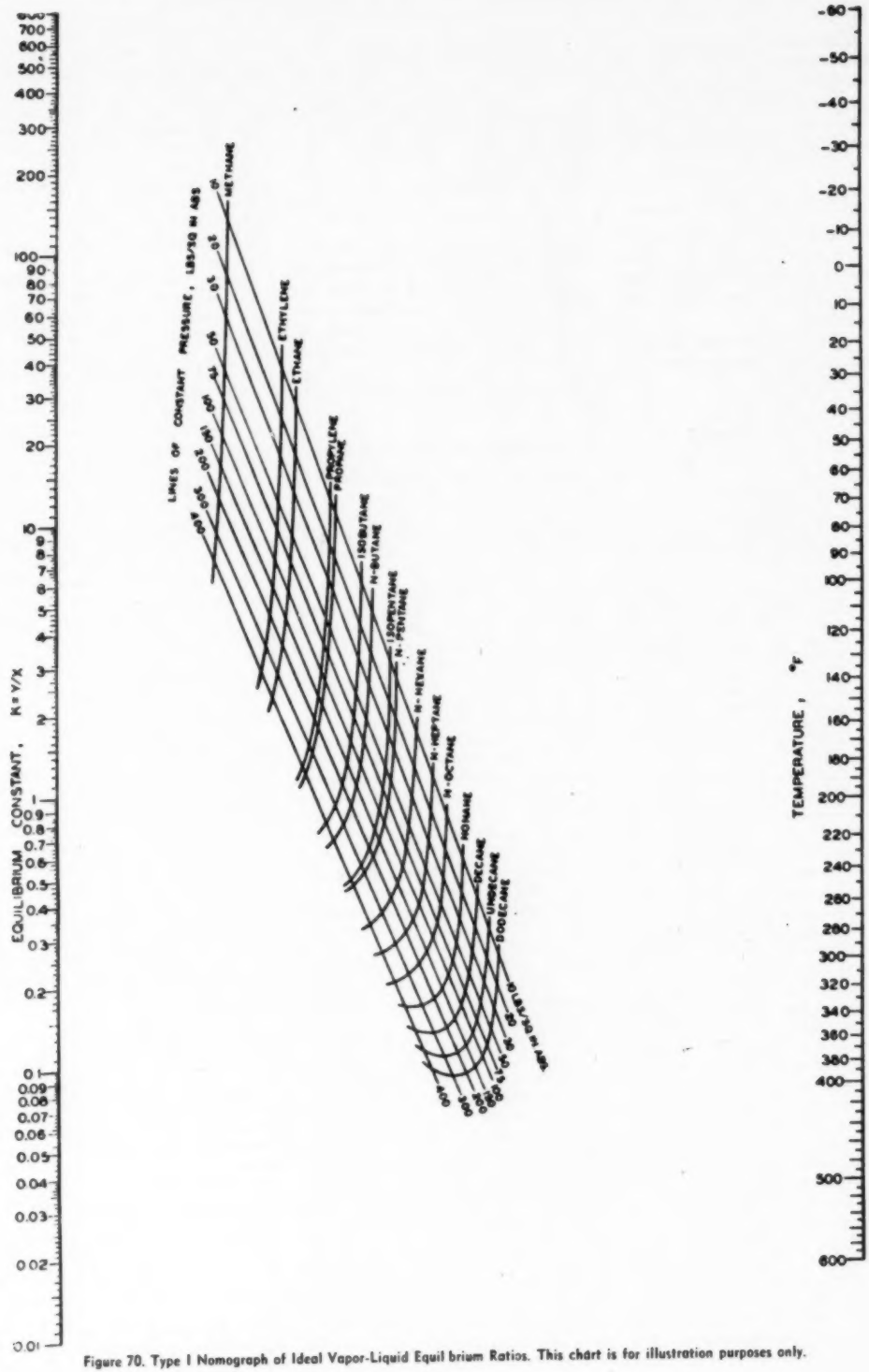


Figure 70. Type I Nomograph of Ideal Vapor-Liquid Equilibrium Ratios. This chart is for illustration purposes only.

Figure 66 and this example are presented to illustrate the effect of pressure on the liquid fugacity and how it might be computed. This correction is of lesser importance than the corrections for deviations from ideal solutions.

Calculation of Ideal K Values

Liquid and vapor fugacities of components in ideal mixtures have been computed in the above examples. These steps will now be consolidated into one procedure.

The equation for the ideal K value is found by combining equations 347, 348 and 350, giving

$$K = \frac{y}{x} = \frac{\pi}{P}\,\frac{(f_\pi/\pi)}{(f_P/P)}\left(\frac{v}{-}\right)^{Z_{av}}$$

Where:

π = vapor pressure

P = system pressure

Z_{av} = compressibility factor of the liquid at log mean average of π and P.

f_π/π = activity coefficient of pure component at vapor pressure = reading of f/P from Figure 62 at reduced temperature of system and the reduced vapor pressure of component;

f_P/P = activity coefficient of pure component at system pressure = reading of f/P from Figure 62 at reduced temperature and the reduced pressure of the system.

When the ratio of the activity coefficients is unity and the pressure correction term to the liquid fugacity also unity, the K value becomes π/P as given by Raoult's and Dalton's laws as expressed by equation 334.

All terms in equation 351 are evaluated at the same temperature.

Ideal vapor-liquid equilibrium ratios have been developed at Massachusetts Institute of Technology and University of Michigan. The M.I.T. charts were distributed rather widely throughout industry by means of notes issued to students. Also Sherwood[20] included tabulated values in his test on "Absorption and Extraction."

The University of Michigan charts have been published in articles by G. G. Brown and his associates.[2, 3, 21] These two sets of ideal equilibrium constants are not in complete agreement, as can be seen from the comparison shown in the table at top of column 2.

The values for methane and ethane are not strictly comparable because the Michigan values are for these hydrocarbons in 200 mol. weight solvent. The other values should be in agreement, however. Since they are not, that indicates that a thorough and critical review of fugacities, vapor pressures, critical constants, and the computation methods is required for the ideal fugacity K values. Unless agreement can be reached on the correct values of ideal fugacity equilibrium constants there is not much hope for reaching agreement on fugacities and K values for non-ideal systems.

K = y/x values at 300 psia.

	100 °F.		300 °F.	
	M.I.T.	U. of M.	M.I.T.	U. of M.
CH_4	9.5	13.0	22.0	15.0
C_2H_6	1.95	2.1	6.4	5.4
C_3H_8	0.74	0.70	2.75	2.69
iC_4H_{10}	0.365	0.315	1.65	1.75
nC_4H_{10}	0.280	0.22	1.43	1.50
iC_5H_{12}	0.120	0.095	0.90	0.93
nC_5H_{12}	0.96	0.072	0.80	0.80

Correlation of Ideal K Values

Vapor-liquid equilibrium ratios have been correlated in several ways: tabulations, log-log graphs, semi-log graphs, and nomographs. A few of these will be illustrated and discussed.

In Figures 67 and 68 the same K values for n-butane are plotted in two different ways, each being the cross plot of the other. Figure 67 illustrates the type of plot prepared at M.I.T. in the 1930's in correlating the K values for hydrocarbons, while Figure 68 illustrates the type of plot prepared at Michigan about the same time in correlating K values for hydrocarbons.

If K values from theoretical calculations or experimental measurements are plotted simultaneously in the ways illustrated by Figures 67 and 68, it is easy to smooth the data. In Figure 67 the isotherms do not cross, which is an advantage. In Figure 68, on the other hand, the isobars do cross.

With either type plot, it is necessary to have as many charts as there are components in the system. Using a number of charts for each equilibrium computation is inconvenient. This has prompted many to replot the K values in different ways.

One method of plotting K values is illustrated by Figure 69, where K values for a series of hydrocarbons at a pressure of 300 psia. are plotted on a Cox-type chart. Similar charts for other pressures are necessary in this method of plotting, thus requiring charts for 100, 150, 200, 250, 300, etc. pressures. Although this method saves no paper or notebook space over methods represented by Figures 67 and 68, it is more convenient for use in design work. This convenience is due to the fact that most hydrocarbons equilibrium calculations are at a given pressure, which means that the chart for the proper pressure may be used for all the readings.

Nomographs have been used in several different forms for correlating K values. Figure 70 is a simple nomograph that the author constructed in 1939 by plotting ideal fugacity K values. Figure 70 was never published because it was not considered accurate enough. An objection to Figure 70 is the condensed nature of the K scale, which contains 5 log banks thus making it very difficult to obtain accurate readings.

Othmer[16] published two nomographs for K data in 1944. One was of the type shown in Figure 70 and the other was of the type shown in Figure 71, which is a modification of one proposed in 1945 by Scheibel and Jenny.[17] In this second style of nomograph pressures and temperatures are laid out on two parallel scales and the K values are marked off on curved hydrocarbon lines in between the T and P scales. The latter type has the advantages of greater reading precision and requiring only one setting for a series of K readings for several hydrocarbons at the same conditions.

Scheibel and Jenny[17] used the M.I.T. data for methane through octane and the Michigan data for nonane through tetradecane. The resulting combination gives hydrocarbon K scales that are irregularly spaced. Figure 71 is a reconstructed modified and smoothed Scheibel-Jenny nomograph.

Shiah[18] correlated in 1942 vapor-liquid equilibrium ratios for hydrocarbons by a reference line method, using n-Pentane as the basis. In this method K values for other hydrocarbons are found from an n-pentane K chart by using an equivalent temperature, which is the temperature of n-pentane where the K value of n-pentane is the same as the K value of the hydrocarbon in question. The equivalent temperature plot accompanying the n-pentane K-value graph was made on reciprocal of absolute temperature scales giving straight lines that intersected at a common point.

This method of correlating data is based on the fact that the shape of the K-vs.-P plots is similar for different temperatures and hydrocarbons. The actual temperatures for different hydrocarbons corresponding to the same temperature for n-pentane are given below.

Temperature °F. of Reference Component	Temperature °F. at Same Value for Reference Component			
n-Pentane	Propane	Butane	Hexane	Heptane
0	−67	54	102	
100	−60	22	162	220
200	25	115	270	330

An objection to this method is that the reference component K value plot must be made for a very wide range

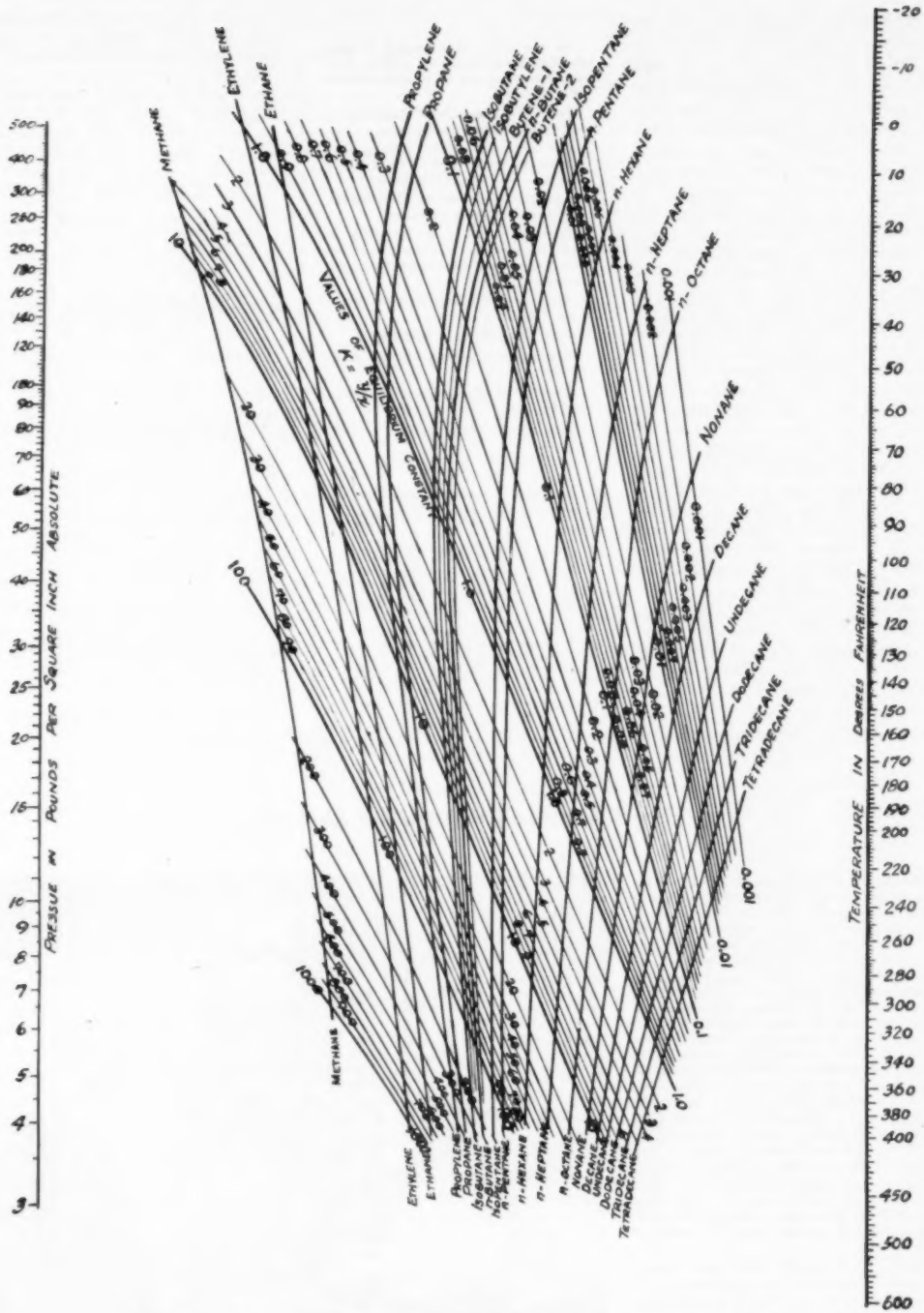


Figure 71. Type II Nomograph of Ideal Vapor-Liquid Equilibrium Ratios. This chart is for illustration purposes only. Reprinted from *Chemical Engineering Progress* 44, 154 (1948).

of temperature in order to cover the lower and higher boiling components. As Scheibel and Jenny[17] point out, this (Shiah's) correlating method is not strictly correct because the relation between the temperatures at which any two compounds have the same K value is not independent of pressure.

Miller and Barley[14] correlated in 1944 the vapor-liquid equilibrium ratio for hydrocarbons as a unique function of the system pressure and the fugacity of the liquid at its vapor pressure, obtaining a single correlation of K as a function of P and f_{π}^{L} and independent of the hydrocarbon. In this correlation method the variation of K for the different hydrocarbons is covered by the values of f_{π}^{L}, which also covers the temperature variable.

Two graphs are required for the Miller-Barley method, a liquid fugacity vs temperature plot similar to Figure 65 and a log-log plot of K-vs.-P for lines of constant f_{π}^{L}. The authors combine these into one nomograph, which uses three parallel scales, a reference line, and a row of spots.

All these condensed correlation methods sacrifice accuracy and precision of reading values. However, they might be useful in suggesting ways of correlating non-ideal K values.

It appears that the best procedure for correlating hydrocarbon equilibrium ratios is to correlate the fugacities for the two phases separately.

For the advice of interested readers, Mr. Edmister's remaining articles have been tentatively set up to appear under titles as follow:

Part XX—Vapor-Liquid Equilibria in Non-Ideal Hydrocarbon Systems.

Part XXI—Convergence Pressure Corrections to High-Pressure Vapor-Liquid Equilibria for Hydrocarbon Systems.

Part XXII—Equilibrium Flash Vaporization of Petroleum Fractions.

Part XXIII—Effect of Pressure on Phase Relations for Petroleum Fractions Plus Properties of Equilibrium Vapor and Liquid.

Part XXIV—Enthalpy Plots for Petroleum Fractions.

Part XXV—Heats of Reactions.

Part XXVI—Chemical Reaction Equilibrium.

Part XXVII—Compression and Expansion of Gases.

Part XXVIII—Refrigeration.

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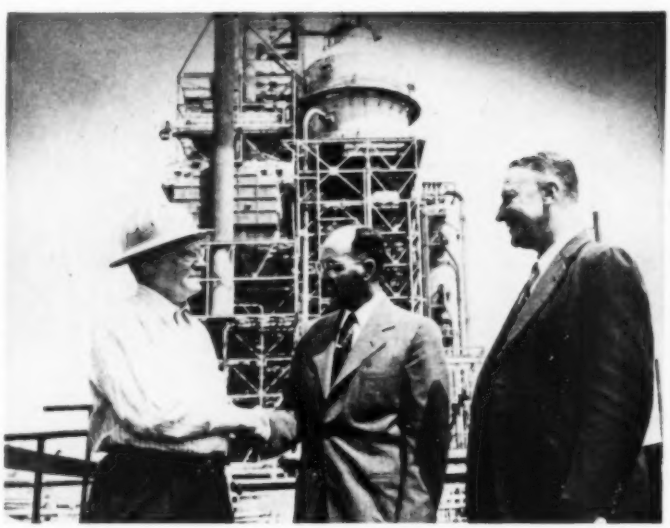
(End of Part XIX. Part XX will appear in an early issue.)

Esso Celebrates 40th Louisiana Anniversary

Esso Standard Oil Company, which began operations in Louisiana April 13, 1909, celebrated its 40th anniversary last month with a statewide program as well as ceremonies at the Baton Rouge Refinery, where tribute was paid 66 active and 91 retired employes who were on the original payroll in 1909. These included 25 employes and annuitants of the Sales Division, which established its Louisiana headquarters in New Orleans at the time construction of the refinery began in Baton Rouge. Including those on the 1909 roll, retired employes invited to the ceremony number more than 400. The contributions of the "old-timers" to the progress made by the oil industry during the last four decades were featured in talks by Vice President Cecil Morgan, H. J. Voorhies, general manager of the refinery, and other company officials.

Since 1909 more than a billion barrels of crude oil have been processed at the Baton Rouge refinery. Employes who are drawn from every section of the state, total more than 9000 representing an annual payroll in excess of $37 million.

In the photo Morgan (right) and Voorhies (center) visit one of the plant's old-timers, S. O. Beauchamp, a refinery stillman, whose employment dates back to 1909. Beauchamp has two daughters, Ruth and Hilda, who are office employes at the plant also.



THE METHOD of selection and usefulness of the data presented here have been discussed in detail in the introductory paper.[8] The second and third papers[9,10] presented the best available thermodynamic data on the lower paraffinic and monoolefinic hydrocarbons, respectively. This article, the fourth in the series, contains the recommended thermodynamic data for the cycloparaffinic hydrocarbons, cyclopentane, methyl cyclopentane, cyclohexane and methyl cyclohexane.

Dr. Kobe is professor of chemical engineering at the University of Texas and Mr. Long is Celanese Corporation Fellow in chemical engineering there.

THERMOCHEMISTRY for the Petrochemical Industry

Part IV—Cycloparaffinic Hydrocarbons

KENNETH A. KOBE and ERNEST G. LONG
Department of Chemical Engineering
University of Texas, Austin

TABLE 1
Reported Heat Capacities of Cycloparaffins.

Compound	Temperature Range	Method	Workers	Reference
Cyclopentane	353 to 539 °K.	Calorimetric	Spitzer and Pitzer	13
	298 to 1500 °K.	Spectroscopic	Kilpatrick, Pitzer and Spitzer	6
	273 to 1500 °K.	Compilation	API 44	12
Methylcyclopentane	273 to 1500 °K.	"Increments"	Kilpatrick, Werner, Beckett, Pitzer and Rossini	7
	273 to 1500 °K.	Compilation	API 44	12
Cyclohexane	410 °K.	Calorimetric	Bennewits and Rossner	2
	384 to 544 °K.	Calorimetric	Spitzer and Pitzer	13
	370 to 410 °K.	Calorimetric	Montgomery and de Vries	11
	410 °K.	Supersonic	Jatkar	5
	370 °K.	C_p Ratio	Dejardin	4
	250 to 1500 °K.	Spectroscopic	Stull and Mayfield	14
	298 to 1500 °K.	Spectroscopic	Beckett, Pitzer, Spitzer	1
	298 to 1500 °K.	Spectroscopic	Brickwedde, Moskow and Aston	3
	273 to 1500 °K.	Compilation	API 44	12
Methylcyclohexane	410 °K.	Calorimetric	Bennewits and Rossner	2
	398 to 527 °K	Calorimetric	Spitzer and Pitzer	13
	390 to 410 °K.	Calorimetric	Montgomery and de Vries	11
	250 to 1500 °K.	Spectroscopic	Stull and Mayfield	14
	298 to 1500 °K.	Spectroscopic	Beckett, Pitzer and Spitzer	1
	273 to 1500 °K.	Compilation	API 44	12

TABLE 2
Free Energy of Formation, Heat of Formation and Heat of Combustion of Cycloparaffins, at 25° C.[1]

	Molecular Weight	$\Delta G°_f$ cal./g-mole	$\Delta H°_f$ cal./g-mole	$-\Delta H°_c$ cal./g-mole	
				H_2O (liq.), CO_2 (gas)	H_2O (gas), CO_2 (gas)
Cyclopentane	70.130	9,230	−18,450	793,390	740,790
Methylcyclopentane	84.156	8,550	−25,500	948,720	885,600
Cyclohexane	84.156	7,590	−29,430	944,790	881,670
Methylcyclohexane	98.182	6,520	−36,990	1,099,590	1,025,950

[1]—$\Delta H°_c$ represents the heat evolved at 25° C. and constant pressure in the combustion of the gaseous hydrocarbon in gaseous oxygen to form the products indicated with all the reactants and products in their appropriate standard reference states.

$\Delta H°_f$ and $\Delta G°_f$ represent the changes in the heat content (enthalpy) and free energy, respectively, for the formation of the gaseous hydrocarbons from the elements, with all the reactants and products in their appropriate standard reference states.

RECENT accurate calorimetric data by Spitzer and Pitzer[13] are available for cyclopentane, cyclohexane and methyl cyclohexane. These data are in good agreement with the spectroscopic calculations of Kilpatrick, Pitzer and Spitzer[6] for cyclopentane and Beckett, Pitzer and Spitzer[1] for cyclohexane and methyl cyclohexane.

Apparently there have been no calorimetric determinations of the heat capacity of methyl cyclopentane. The data used here are the calculations of Kilpatrick, Werner, Beckett, Pitzer and Rossini[7] of the American Petroleum Institute Research Project 44. In this article the thermodynamic functions of methyl cyclopentane were calculated by the following formula:

[Methyl cyclopentane]=[Cyclopentane] + [Methyl] + [Restricted rotation of ring puckering] + (R ln 10), (1)

in which [Methyl] was calculated by

[Methyl] = [Methyl cyclohexane] − [Steric factor] − [Cyclohexane] − (R ln 6). (2)

The symmetry number corrections, which are written in parentheses, were used for the free energy function and for the entropy but not for the other functions (which includes heat capacity). Thus it is seen that the thermodynamic functions of methyl cyclopentane have been calculated by combining the known values for cyclopentane with the known effects of the methyl group upon the paraffinic ring. The resulting values, although they are not calculated by fundamental methods, are probably accurate and they have been accepted and reported by the API 44 report.[12]

The limited sources of heat capacity data on these compounds are listed in Table 1. Table 2 contains the standard heats of formation and combustion and the standard free energies of formation from the API 44 report.

The heat capacity data, chosen from the sources discussed above, are tabulated on the four temperature scales in Tables 3, 4, 5 and 6. Figure 1 is a plot of these data on the Centigrade and Fahrenheit temperature scales.

Tables 7, 8, 9 and 10 are tabulations of the molal enthalpies (heat contents) relative to 0° C. = 32° F. These data were calculated by careful integration of the reported heat capacity data. Figure 2 is a convenient double logarithmic plot of the results on the Centigrade temperature scale.

From the enthalpy data of Tables 7 and 9 were calculated mean heat capacity values relative to the ice-point

TABLE 3
Heat Capacities of Cycloparaffins
cal./g-mole · °C.

°C.	Cyclopentane	Methyl Cyclopentane	Cyclohexane	Methyl Cyclohexane
0	17.71	23.80	22.82	29.25
18	19.23	25.56	24.68	31.42
25	19.82	26.24	25.40	32.27
100	26.07	33.58	33.10	41.25
200	33.91	42.68	42.98	52.43
300	40.72	50.54	51.71	62.13
400	46.44	57.11	59.10	70.28
500	51.27	62.65	65.28	77.10
600	55.37	67.38	70.45	82.83
700	58.89	71.45	74.76	87.64
800	61.94	74.97	78.4	91.7
900	64.55	77.98	81.5	95.1
1000	66.81	80.60	84.1	98.1
1100	68.76	82.87	86.3	100.6
1200	70.47	84.85	88.1	102.7

TABLE 4
Heat Capacities of Cycloparaffins
cal./g-mole · °K.

°K.	Cyclopentane	Methyl Cyclopentane	Cyclohexane	Methyl Cyclohexane
273	17.71	23.80	22.82	29.25
291	19.23	25.56	24.68	31.42
298	19.82	26.24	25.40	32.27
300	19.98	26.46	25.58	32.51
400	28.24	36.11	35.82	44.35
500	35.86	44.94	45.47	55.21
600	42.36	52.43	53.83	64.46
700	47.81	58.68	60.87	72.23
800	52.44	64.00	66.76	78.74
900	56.37	68.53	71.68	84.20
1000	59.75	72.44	75.80	88.79
1100	62.68	75.82	79.3	92.7
1200	65.18	78.72	82.2	96.0
1300	67.36	81.24	84.7	98.8
1400	69.24	83.43	86.8	101.2
1500	70.89	85.35	88.6	103.2

TABLE 6

Heat Capacities of Cycloparaffins

Btu./lb.-mole · °R.

°R.	Cyclopentane	Methyl Cyclopentane	Cyclohexane	Methyl Cyclohexane
492	17.71	23.80	22.82	29.25
500	18.06	24.24	23.27	29.78
520	19.02	25.33	24.41	31.12
537	19.82	26.24	25.40	32.27
600	22.68	29.72	28.91	36.41
700	27.33	35.05	24.68	43.04
800	31.66	40.08	40.15	49.24
900	35.86	44.94	45.47	55.21
1000	39.53	49.17	50.18	60.43
1100	42.99	53.15	54.64	65.35
1200	46.02	56.63	58.56	69.68
1300	48.84	59.85	62.18	73.67
1400	51.44	62.85	65.49	77.33
1500	53.75	65.52	68.42	80.57
1600	55.94	68.04	71.15	83.61
1700	57.87	70.27	73.52	86.24
1800	59.75	72.44	75.80	88.79
1900	61.37	74.31	77.8	90.9
2000	62.96	76.14	79.6	93.1
2100	64.35	77.75	81.2	94.9
2200	65.64	79.24	82.7	96.5
2300	66.88	80.68	84.2	98.2
2400	67.96	81.93	85.4	99.5
2500	69.02	83.18	86.6	100.9
2600	69.94	84.25	87.6	102.0

TABLE 7

Enthalpies of Cycloparaffins

cal./g-mole

°C.	Cyclopentane	Methyl Cyclopentane	Cyclohexane	Methyl Cyclohexane
0	0.0	0.0	0.0	0.0
18	332.8	444.6	427.6	546.2
25	469.4	625.9	602.8	769.2
100	2191.	2871.	2796.	3527.
200	5193.	6689.	6604.	8216.
300	8932.	11360.	11350.	13950.
400	13290.	16750.	16890.	20570.
500	18180.	22740.	23110.	27940.
600	23520.	29240.	29890.	35940.
700	29230.	36180.	37150.	44460.
800	35270.	43500.	44810.	53420.
900	41590.	51150.	52800.	62760.
1000	48160.	59070.	61070.	72410.
1100	54940.	67240.	69590.	82350.
1200	61890.	75630.	78310.	92500.

TABLE 8

Enthalpies of Cycloparaffins

cal./g-mole.

°K.	Cyclopentane	Methyl Cyclopentane	Cyclohexane	Methyl Cyclohexane
273	0.0	0.0	0.0	0.0
291	332.8	444.6	427.6	546.2
298	469.4	625.9	602.8	769.2
300	509.2	678.6	653.8	834.0
400	2915.	3799.	3714.	4667.
500	6123.	7856.	7782.	9649.
600	10038.	12730.	12750.	15640.
700	14550.	18290.	18480.	22470.
800	19560.	24420.	24860.	30020.
900	25010.	31050.	31790.	38160.
1000	30810.	38100.	39160.	46810.
1100	36930.	45510.	46910.	55880.
1200	43320.	53240.	54980.	65310.
1300	49950.	61230.	63320.	75040.
1400	56770.	69460.	71900.	85030.
1500	63830.	77890.	80660.	95250.

and these values are given in Tables 11 and 12.

Accurate heat capacity equations have been calculated on all four of the temperature scales and are listed in Table 13.

TABLE 9

Enthalpies of Cycloparaffins

Btu./lb.-mole.

°F.	Cyclopentane	Methyl Cyclopentane	Cyclohexane	Methyl Cyclohexane
32	0.0	0.0	0.0	0.0
60	514.6	688.2	661.6	845.6
77	844.9	1127.	1085.	1385.
100	1313.	1745.	1685.	2145.
200	3634.	4769.	4640.	5858.
300	6410.	8323.	8161.	10220.
400	9621.	12383.	12230.	15210.
500	13240.	16910.	16820.	20790.
600	17230.	21870.	21880.	26870.
700	21560.	27220.	27380.	33440.
800	26190.	32920.	33270.	40450.
900	31100.	38940.	39520.	47850.
1000	36270.	45250.	46100.	55610.
1100	41670.	51830.	52970.	63690.
1200	47280.	58650.	60100.	72080.
1300	53090.	65700.	67470.	80720.
1400	59070.	72960.	75060.	89620.
1500	65230.	80410.	82860.	98730.
1600	71530.	88040.	90830.	108050.
1700	77980.	95820.	98970.	117550.
1800	84560.	103760.	107250.	127220.
1900	91250.	111840.	115680.	137000.
2000	98060.	120040.	124230.	147000.
2100	104970.	128370.	132900.	157100.
2200	111970.	136800.	141700.	167300.

TABLE 10

Enthalpies of Cycloparaffins

Btu./lb.-mole.

°R.	Cyclopentane	Methyl Cyclopentane	Cyclohexane	Methyl Cyclohexane
492	0.0	0.0	0.0	0.0
500	143.2	192.2	184.4	236.2
520	514.6	688.2	661.6	845.6
537	844.9	1126.6	1085.1	1384.5
600	2186.	2889	2798.	3548.
700	4690.	6128.	5981.	7527.
800	7646.	9888.	9725.	12146.
900	11021.	14140.	14008.	17370.
1000	14790.	18850.	18790.	23150.
1100	18920.	23970.	24030.	29440.
1200	23380.	29460.	29690.	36190.
1300	28120.	35290.	35730.	43390.
1400	33140.	41430.	42110.	50910.
1500	38400.	47850.	48810.	58810.
1600	43890.	54530.	55790.	67010.
1700	49580.	61450.	63020.	75500.
1800	55460.	68580.	70480.	84250.
1900	61520.	75920.	78140.	93240.
2000	67730.	83440.	86020.	102430.
2100	74100.	91130.	94070.	111820.
2200	80600.	98980.	102280.	121400.
2300	87220.	106980.	110610.	131100.
2400	93960.	115110.	119100.	141000.
2500	100810.	123360.	127700.	151000.
2600	107760.	131730.	136400.	161200.

TABLE 11

Mean Heat Capacities of Cycloparaffins

cal./g-mole · °C.

°C.	Cyclopentane	Methyl Cyclopentane	Cyclohexane	Methyl Cyclohexane
0	17.71	23.80	22.82	29.25
18	18.49	24.70	23.75	30.35
25	18.78	25.04	24.11	30.77
100	21.91	28.71	27.96	35.27
200	25.97	33.44	33.02	41.06
300	29.77	37.86	37.82	46.51
400	33.24	41.87	42.22	51.43
500	36.36	45.47	46.21	55.88
600	39.20	48.74	49.82	59.90
700	41.76	51.69	53.07	63.51
800	44.09	54.38	56.01	66.78
900	46.22	56.83	58.67	69.73
1000	48.16	59.07	61.07	72.41
1100	49.94	61.13	63.26	74.86
1200	51.58	63.02	65.26	77.09

TABLE 12

Mean Heat Capacities of Cycloparaffins

Btu./lb.-mole · °F.

°F.	Cyclopentane	Methyl Cyclopentane	Cyclohexane	Methyl Cyclohexane
32	17.71	23.80	22.82	29.25
60	18.38	24.58	23.63	30.20
77	18.78	25.04	24.11	30.77
100	19.31	25.66	24.77	31.54
200	21.63	28.38	27.62	34.87
300	23.92	31.05	30.45	38.15
400	26.14	33.65	33.24	41.33
500	28.29	36.14	35.94	44.40
600	30.33	38.51	38.53	47.30
700	32.27	40.75	40.99	50.06
800	34.10	42.87	43.32	52.66
900	35.83	44.86	45.53	55.12
1000	37.47	46.74	47.62	57.45
1100	39.01	48.53	49.59	59.64
1200	40.48	50.21	51.45	61.71
1300	41.87	51.81	53.21	63.66
1400	43.18	53.33	54.87	65.51
1500	44.43	54.77	56.44	67.25
1600	45.62	56.15	57.93	68.91
1700	46.75	57.45	59.33	70.48
1800	47.83	58.69	60.66	71.96
1900	48.85	59.87	61.93	73.37
2000	49.83	61.00	63.12	74.70
2100	50.76	62.07	64.26	75.97
2200	51.65	63.10	65.34	77.18

TABLE 13

Heat Capacity Equations[1] of Cycloparaffinic Hydrocarbons

cal./g-mole · °C. or °K.

Btu./lb.-mole · °F. or °R.

$$C_p^\circ = a + b(t) + c(t^2) + d(t^3)$$

		a	$b \times 10^2$	$c \times 10^5$	$d \times 10^8$	ERROR Max. Percent	ERROR Avg. Percent
Cyclopentane:	°C.	17.540	9.388	−6.103	1.641	1.00	0.25
	°K.	−12.957	13.087	−7.447	1.641		
	°F.	15.901	5.326	−1.910	0.2814		
	°R.	−12.957	7.271	−2.298	0.2814		
Methylcyclopentane:	°C.	23.620	10.960	−7.275	2.003	0.86	0.23
	°K.	−12.114	15.380	−8.915	2.003		
	°F.	21.699	6.230	−2.278	0.3434		
	°R.	−12.114	8.544	−2.752	0.3434		
Cyclohexane:	°C.	22.500	11.860	−7.625	1.927	1.57	0.37
	°K.	−15.935	16.454	−9.203	1.927		
	°F.	20.424	6.737	−2.385	0.3304		
	°R.	−15.935	9.141	−2.841	0.3304		
Methylcyclohexane:	°C.	29.000	13.510	−9.016	2.409	0.92	0.22
	°K.	−15.070	18.972	−10.989	2.409		
	°F.	26.639	7.681	−2.822	0.4131		
	°R.	−15.070	10.540	−3.392	0.4131		

[1] Temperature Ranges: 0—1200 °C. 273—1500 °K. 32—2200 °F. 492—2600 °R.

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TABLE 5

Heat Capacities of Cycloparaffins
Btu./lb.-mole • °F.

°F.	Cyclo-pentane	Methyl Cyclo-pentane	Cyclo-hexane	Methyl Cyclo-hexane
32	17.71	23.80	22.82	29.25
60	19.02	25.33	24.41	31.12
77	19.82	26.24	25.40	32.27
100	21.88	27.52	26.69	33.81
200	25.51	32.92	32.40	40.43
300	29.97	38.12	38.00	46.92
400	34.21	43.03	43.37	52.96
500	38.11	47.54	48.36	58.41
600	41.65	51.61	52.92	63.46
700	44.86	55.30	57.06	68.02
800	47.77	58.63	60.82	72.17
900	50.44	61.69	64.22	75.92
1000	52.86	64.49	67.30	79.33
1100	55.09	67.06	70.09	82.42
1200	57.12	69.40	72.60	85.22
1300	59.00	71.57	74.89	87.77
1400	60.73	73.57	76.98	90.10
1500	62.33	75.41	78.9	92.2
1600	63.79	77.10	80.6	94.2
1700	65.14	78.66	82.1	95.9
1800	66.39	80.11	83.6	97.5
1900	67.54	81.44	84.9	99.0
2000	68.59	82.67	86.1	100.3
2100	69.58	83.82	87.2	101.6
2200	70.49	84.89	88.2	102.7

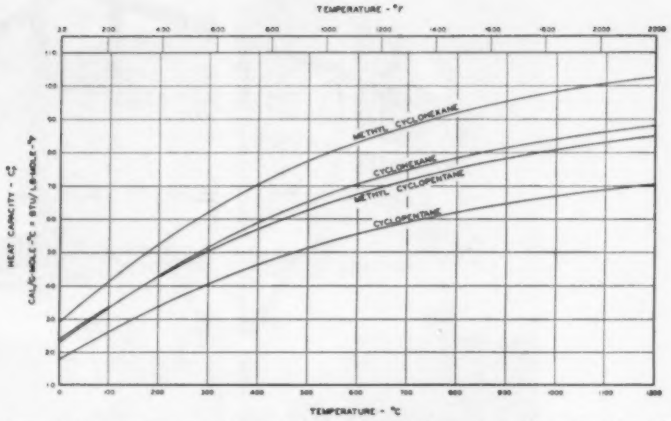

Figure 1. Heat capacity curves for cyclopentane methyl cyclopentane, cyclohexane and methyl cyclohexane.

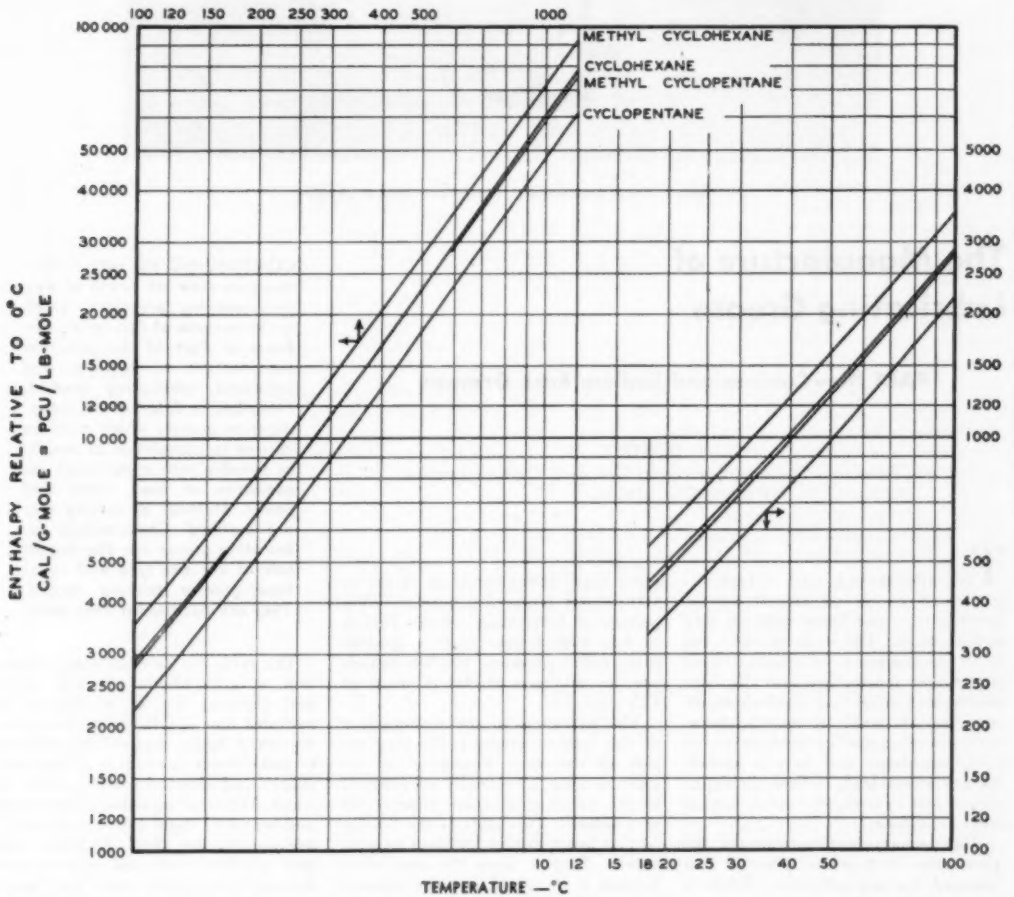

Figure 2. Relative enthalpies for cyclopentane, methyl cyclopentane, cyclohexane and methyl cyclohexane. Multiply readings in P.c.u./lb.-mole by 1.8 to obtain Btu./lb.-mole.

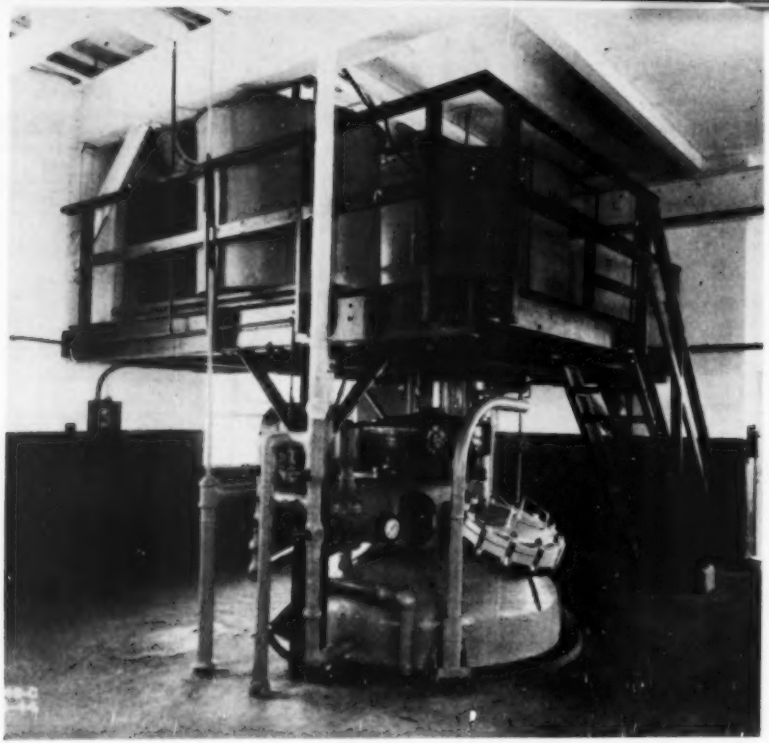

Figure 1. Top of Autoclave with Weigh Tanks Used in Charging.
(Photo Courtesy The Texas Company.)

The Manufacture of Lubricating Grease

PART III—Calcium and Sodium Base Greases

C. J. BONER
Chief Research Chemist, Battenfeld Grease & Oil Corporation, Kansas City, Missouri

CONTINUING the rather thorough review of present day greasemaking practices, which is the purpose of this series, Mr. Boner in Part III discusses the manufacture of calcium and soda-base lubricating greases. Described in detail is the saponification process which must be carried to completion as rapidly as possible with a minimum expenditure of heat, labor and power. Methods of testing also are outlined. Calcium-base lubricating grease has the largest sale of any one type with soda-base greases ranking second. They are discussed in that order.

THE calcium-base type of lubricating grease enjoys the largest sale of any one type and hence deserves first consideration. The reasons for the large consumption of calcium base lubricating greases are that they are moderate in price, have good resistance to water, are stable at most temperatures encountered in automotive or farm machinery and have a smooth texture which leads to ease in application and contributes to low torque when in service.

The primary heat requirement for processing in a grease plant is that required for saponification. While a heat balance can be worked out, the steam requirements are generally arrived at by empirical data. Klemgard[3] states that 1800 pounds of steam at 100 psi. are required to produce 7500 pounds of lubricating grease. This is in line with figures from a modern plant which produces 100,000 pounds per day and uses 26,000 of steam at 125 psi.

The first step in the manufacture of this type of grease is the preparation of the soap. Formation of the calcium soap is normally carried out in the presence of some mineral oil as a diluent. This adds to the fluidity so that better mixing and heat transfer results. Further, since the soap when formed is dispersed in some mineral oil it mixes more readily with the remainder of the oil without formation of lumps.

The cycle for calcium soap formation at atmospheric pressure starts with charging the fat, an amount of hydrated lime equivalent to about one-seventh of the fat, mineral oil sufficient to make about one-fourth of the total charge and about one-half percent of water. The other ingredients are mixed and heated to about 140° F. before the addition of dry lime. Agitation and heat are then continued until saponification is complete, unless the charge foams up in the kettle, in which case the steam may have to be turned off and the pressure released from the

jacket until foaming subsides. It is evident, from the above, that vessels must have considerable freeboard during the process of saponification. Thus, the volume of the initial charge should never be more than one-fourth the total kettle capacity.

Immediately after lime is added it reacts with part of the fatty acids present in the fat and the resulting soap acts as an emulsifier of the entire mixture. This, of course, contributes to the intimate contact of the reacting ingredients. A few pounds of caustic soda is sometimes added in place of the equivalent of lime as a means of speeding up saponification. When saponification is virtually complete the mixture will have a consistency similar to taffy and a portion of it when cooled will be brittle like a sheet of glue.

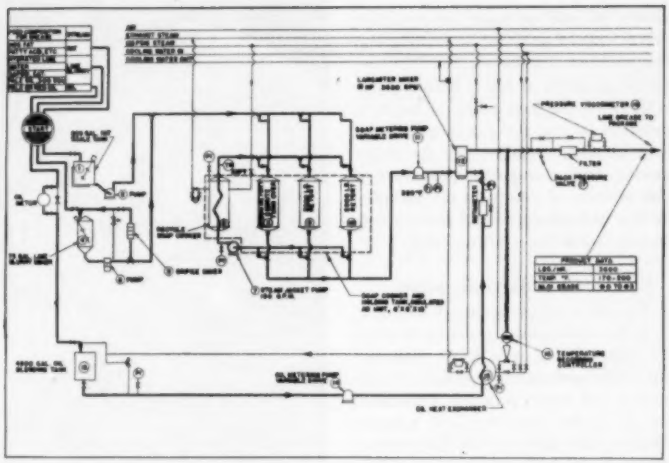

Figure 3. Flow Diagram of Standard Oil Development Continuous Grease Process.
(Courtesy The Girdler Company.)

Laboratory Checks Saponification

The time interval for completion of the saponification will vary from 1½ to 8 hours. The reaction probably never goes to completion since one analysis after 8 hours cooking showed only 97.80 percent of the fat saponified, in spite of the fact that excess lime was used. The old time greasemaker could tell, by examination of a cold sample of the mass, when it had reached a stage which would result in a satisfactory finished grease. Now the laboratory checks a sample of the soap and gives approval when it is ready for compounding.

When this stage has been reached, additional oil is added to reduce the soap percentage to 30 to 35 percent. The mixture is then heated to 220 to 230° F., when it is ready to "tie," a term which denotes formation of a stable structure of the soap in the mineral oil due to the presence of water. If the soap-oil mixture were cooled before the addition of water most of the oil would eventually separate from the soap, but if water is stirred into the mass a plastic product results which is quite stable. This operation can be carried out in the cooker but in most cases the soap-oil mixture is dropped into another open kettle which may or may not be jacketed.

In general, the proportion of water required to produce a stable lubricating grease will be less than 10 percent of the soap present. Of course if the water is added at temperatures above its boiling point some of it will flash off and experience will indicate the excess to use to compensate for this loss. Additions of water can be made at temperatures as low as 185° F. and some plants even keep sufficient water in the mass during saponification so that a plastic product results without the tying operation. There is an optimum water content of a calcium base lubricating grease which will give the best gel structure, but this depends upon a number of factors, such as amount of free acid or alkali present, viscosity and gravity of the oil used or titer of the fat employed. Other compounds have been used as stabilizers for lime soap greases and if these are employed, they are added in about the same manner as the water.

After the soap structure is formed, additional oil is mixed in to bring the product to the desired consistency. During this period the temperature is brought to 170 to 180° F. by discontinuing any jacket heat and adjusting the temperature of the incoming oil if necessary. Likewise, additives such as anti-oxidants, dyes or perfumes are added if required. During this period mixing may be accelerated by circulation with a pump as a supplement to agitation.

The time interval for formation of the grease structure and running up to the proper consistency will vary, but 1 to 2 hours is sufficient. A sample is then sent to the laboratory for consistency tests. After final adjustments as to consistency, followed by screening, the grease is ready to pump to storage or to package. The heavier

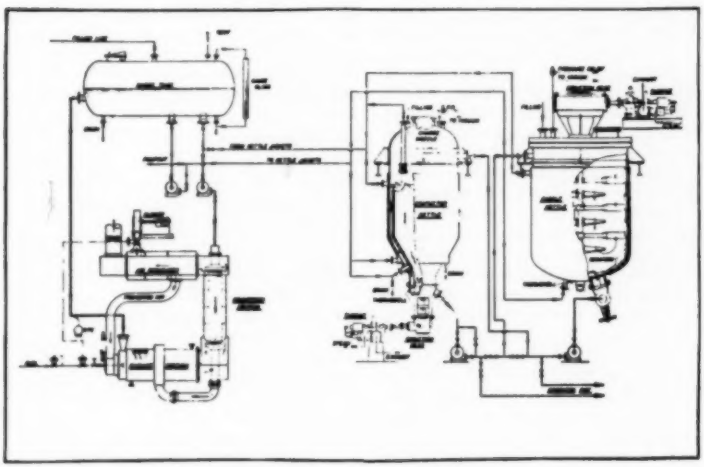

Figure 2. Stratco Grease Process Equipment.
(Courtesy Stratford Engineering Company.)

grades of calcium base lubricating grease should be filled immediately at temperatures not below 170° F. Continual agitation at lower temperatures will soften the grease and if the temperature is low the product will not feed to pumps readily. For the softer grades, tank storage is convenient as this permits of emptying the finishing kettles without delay and assures continuous work for a filling crew.

Pressure Saponification

The charging procedure if lime soap is to be made under pressure is much the same as for open kettle manufacture. The autoclave, Figure 1, is then closed and steam pressure maintained on the jacket for 20 to 30 minutes. During this interval the temperature of the charge will reach at least 300° F. and the internal pressure of the vessel 50 to 80 pounds, with a jacket pressure of 100 pounds.

At the end of the above period the charge is released to a finishing kettle which may contain a small amount of hot oil. The procedure in producing a finished grease is then the same as if the soap had been formed at atmospheric pressure, viz., the quantity of oil and temperature is adjusted to the proper point for tying, when water is added. If excess water was added to the autoclave and sufficient oil was in the finishing kettle to prevent all of this flashing off, no water addition may be required.

If a pressure contactor such as shown in Fig. 2 is used for saponification, the charging procedure and likewise the cycle of operations is about the same as with other autoclaves. An over-all cycle of charging, soap formation and discharge is given as 30 minutes. When the temperature of the charge reaches 370° F. saponification is considered complete, the pressure being about 70 psi.

Since fat is the most expensive item in a calcium-base lubricating grease, the manufacturer is concerned with producing a product of a stated consistency with as low a percentage of soap as possible. It seems reasonable that the more complete the saponification the lower would be the percentage of fat to provide a given consistency. This may not be the only reason for high yields since dispersion may well play a part. In any event, manufacturers who have saponified by all methods described claim a reduction of 10 to 14 percent of fat when a pressure contactor is employed.

The process perfected by Standard Oil Development Company, Figure 3, provides for pressure saponification of fat in lots of 2000 pounds of soap mix. The raw materials are charged into retorts and circulated from these retorts through a heat exchanger which consists of coils of tubing in a steam jacket. The 2000-pound lots turn over in two minutes and the temperature is kept at 320° F. Saponification is complete in 45 minutes. Three retorts are provided so that the continuous compounding system can draw from one containing finished soap while another is being used for saponification and still another being charged.

This hot-soap mix is delivered by a metering pump, together with a measured stream of oil, to a disperser where the grease is formed. Since the soap mix is under pressure from the time saponification starts until it enters the disperser, the water originally charged remains in the system and serves as a "tie." Finished grease is delivered at a rate of 3600 pounds per hour and at a temperature of 170 to 200° F.

At a point just before the grease leaves the system, a pressure viscometer checks the consistency. This apparatus consists of a constriction in a pipe through which a small positive delivery pump forces a stream of grease. If the grease is at a stated temperature, the pressure developed will be proportional to the viscosity or consistency. Controls are provided to permit this instrument to shut down the system if the consistency of the exit grease is too far from that desired.

Claims are made that a 10 percent saving in fat is possible with this process. The one commercial plant now in operation should point out any modifications required.

Figure 4. Forming Locomotive Rod Cup Grease.

Calcium Grease from Fatty Acids

The formation of calcium soap by the reaction of fatty acids and hydrated lime is exothermic and hence once initiated, does not require prolonged heating of the mass. Garlick[2] states that satisfactory calcium base greases can be made by heating fatty acids and four-fifths of the oil required, to 150° F., followed by addition of a dispersion of the lime in the remaining oil. Since the British have the advantage

Figure 5. Grease Penetrometer.
(Courtesy Precision Scientific Company.)

of a considerable supply of wool-grease fatty acids, such ingredients may play a part in the ease of formation. Klemgard[4] on the other hand describes autoclave saponification for the production of fatty acid-lime lubricating greases. Since fatty acids cost about half again as much as fat the proportion of such materials used for production of calcium base greases is not large.

In the manufacture of axle grease the acids formed by heating rosin are reacted with lime. The saponification in this case is so rapid that the actual grease formation takes place in or adjacent to the shipping container. The rosin oil, dispersed in part of the mineral oil, is mixed with hydrated lime dispersed in another portion of oil, all at a temperature of about 100° F. Mixing is done by proportioning pumps, following which the grease forms in a matter of 30 to 60 seconds.

Soda-Base Lubricating Greases

In spite of the fact that soda-base lubricating greases are subject to breakdown by the action of water, the volume of this type sold is probably second only to that of calcium-base grease. This is due primarily to the higher melting point of this type of lubricating grease, and to some extent to the fibrous structure.

Soap Formation at Atmospheric Pressure

A large proportion of soda-base lubricating greases are produced entirely at atmospheric pressure. In such cases the saponification and finishing may be completed in the same vessel. Formation of soda soaps for this purpose is generally carried on in the presence of some mineral oil as an aid to further dispersion and in order to reduce the load on the agitators.

The fat, an equal quantity of oil and sufficient caustic soda to completely saponify the fat are charged. This latter ingredient may be added in the dry state along with water, or it may be added in the form of lye. Agitation and heat on the mixture soon causes some saponification and, with the formation of soap, the mass thickens to the point where the water, trying to escape, results in a very heavy foam. With some charges this foaming is so bad that special provision is made to allow for it. One plant, for example, provided tight stacks almost as large as the diameter of the kettle and permitted the foam to force itself several feet up into these rather than have to curtail the heating and prolong the cooking. Due to this tendency to foam the size of a charge of soda-base grease is generally smaller for a given kettle than that of a calcium-base product.

As saponification nears completion and most of the moisture is driven off, the mass of soap and oil balls up around the shaft and assumes a fibrous texture. Since the fibers cling together a tough mass results which is difficult to mix with further oil. Provision is made to tear this mass up with either double agitators set close together or by means of a breaker bar which arrests the movement of the mass as the agitators rotate it. For this reason the time required for reducing the consistency of heavy soda base lubricating greases is prolonged. Time for saponification may be only 1½ hours but the time for running up will be 4 or 5 hours. Finally a point will be reached where the charge will take oil readily and mixing can be assisted by circulation with a pump.

If the open kettle be fire-heated the temperature can be carried to a point where the soap will actually dissolve, about 350° F., and the texture will form as the mass cools and is agitated. Variation in the character of soda-base lubricating greases is possible by a number of modifications. A high proportion of unsaturated fatty acids in the soap base will give a longer fiber, while a higher titer fat or a small proportion of calcium soap will tend to shorten the fiber.

Soda-base lubricating greases are also made which have a buttery texture. This is accomplished by almost complete dehydration of the soap-oil mixtures, heating to the solution point of the soap in the oil, followed by special chilling. One plant installed a wax chiller for this purpose, consisting of screws moving the grease through a series of water cooled pipes.

Certain railroad locomotive greases consist of cylinder stocks bodied with 40 to 50 percent of soda soap. Since these are almost completely dehydrated and have melting points around 400° F., it is necessary to manufacture them in fire heated kettles unless some medium other than steam is available. One plant is using a kettle heated by Dowtherm for this purpose. The procedure for saponification is similar to that for other soda base greases. After cooling the grease is cut in blocks so as to fit locomotive driving journals or formed under pressure to fit rod cups. This is done by hydraulic presses, see Figure 4.

Saponification Under Pressure

Production of soda-base soap for lubricating greases in closed vessels under pressure has the advantage of increased speed of reaction, more complete saponification and partial elimination of foaming troubles. However, since most soda-base greases are quite low in moisture content, the charge must be dehydrated after the soap is formed. This is done by dropping the batch into an open mixer where agitation and further heating can be carried on.

Soda soap formation can be carried on in any autoclave but the pressure contactor, Figure 2, is particularly recommended. A time cycle of 2½ hours is claimed for the manufacture of a charge of soda base lubricating grease with this equipment. It is recommended that after dehydration the charge be returned to the Contactor for complete blending. At one plant a contactor is used for saponification and another for the final dispersion of the soap following dehydration. It is possible to dehydrate in the pressure vessel if this is equipped for vacuum.

While we know of no continuous process for the manufacture of soda-base lubricating greases, a method of formation suggested by Gallay and co-workers[1] should permit of such procedure for both soda and calcium-base greases. Solid alkali, either calcium or sodium hydroxide, is dispersed in mineral oil by means of a colloid mill. This dispersion is then mixed with a dispersion of fat or fatty acids in another portion of oil. If the final mix is warmed to 140° F. saponification takes place.

Testing Lubricating Greases

Granting that the type of soaps used and the characteristics of the mineral oil in the lubricating grease are known, the purchaser is primarily

interested in the consistency and dropping point of the product. In some cases the resistance of the lubricant to oxidation is also of interest. Since these tests are common to all types of greases a brief description will be given.

Consistencies of lubricating greases are taken in accordance with ASTM method D 217-48, by determining the depth of penetration of a standard cone when released above a sample of the grease. The penetrometer, Figure 5, is an instrument which permits of the accurate adjustment of the tip of the cone to the surface of the sample. The cone assembly, which includes the stem carrying it, weighs 150 grams and provision is made for a dial reading in units, each of which represents 0.1 mm. penetration by the cone. Only hard greases, such as brick greases, have the penetration taken in an unworked state, other types being tested on a worked basis. "Working" consists of adjusting the temperature of the sample to 77° F. and then subjecting this sample to 60 strokes in a grease worker. The worker consists of a cylinder closed at one end and a perforated disc attached to a top so that the disc can be forced back and forth through the sample. Following the working the top is removed and after the sample is leveled off the penetration is taken. An automatic grease worker, Figure 6, is also in use which permits working the grease a determined number of strokes up to 100,000.

The dropping point of a lubricating grease is the temperature at which the grease passes from a semisolid to a liquid state. The apparatus for such measurement, covered by ASTM method D566-42, consists of a small cup with a 7/64 diameter hole in the bottom. The grease is spread around the outer part of the cup, the cup is dropped into a constricted test tube and a thermometer inserted so that its bulb is inside the cup but not touching the grease. The whole is heated in a liquid bath until a drop of grease escapes from the bottom of the cup.

The oxidation stability of a lubricating grease is determined according to ASTM method D942-47T by exposing a weighed amount of the grease on glass dishes in a stainless steel bomb and in an atmosphere of oxygen. The assembly is held at 210° F. and any decrease in oxygen pressure noted after a period of 100 hours. A small loss in oxygen pressure indicates a satisfactory life in service for the lubricant.

Another test which assures satisfactory performance of greases for a specific use is a wheel bearing test. Such a test is conducted with a wheel bearing tester, the use of which is detailed in a proposed method published by the ASTM. The tester consists of a roller bearing and spindle assembly, run at 440 rpm. and held at 220° F., after a definite weight of grease has been packed in the bearings and hub. A grease which softens to a great extent or which does not lubricate under the above conditions is considered unsatisfactory.

End of Part III. Part IV will appear in the June issue.

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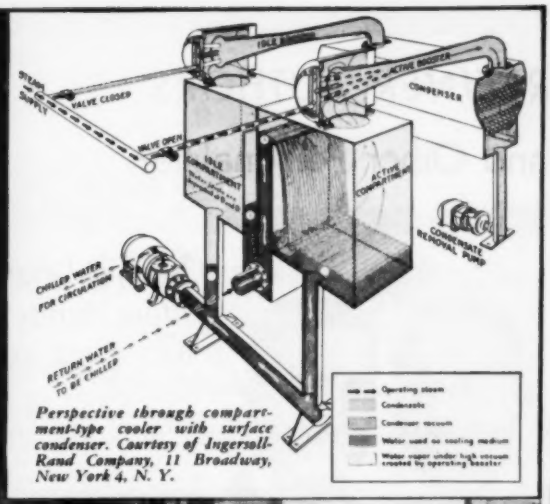
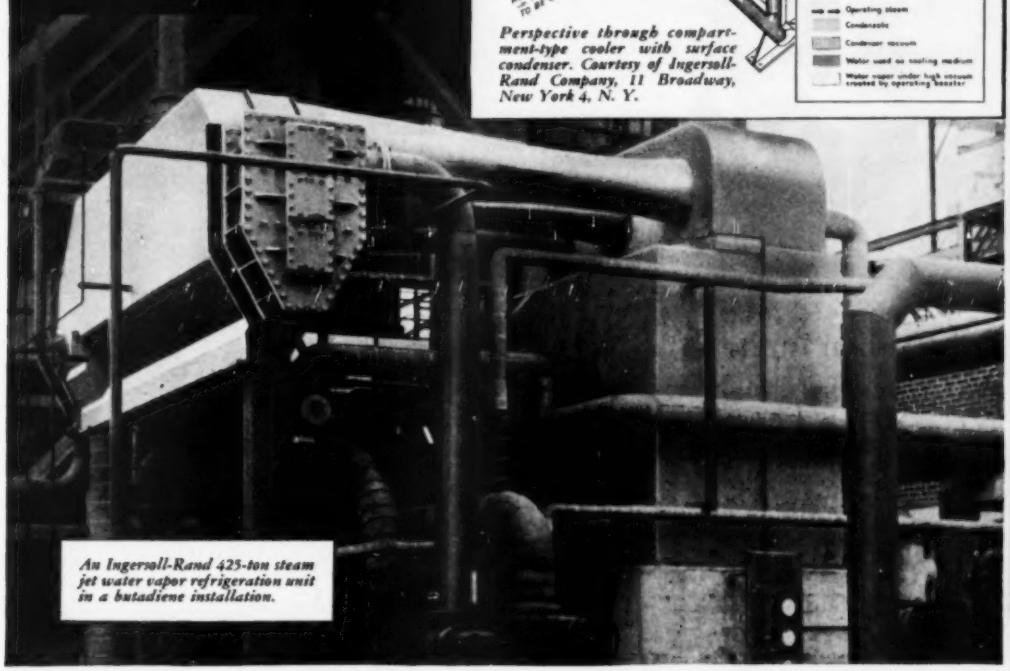
Figure 6. Automatic Grease Worker.
(Courtesy Precision Scientific Company.)

JET OF LIVE STEAM PROVIDES REFRIGERATION



Perspective through compartment-type cooler with surface condenser. Courtesy of Ingersoll-Rand Company, 11 Broadway, New York 4, N. Y.



An Ingersoll-Rand 425-ton steam jet water vapor refrigeration unit in a butadiene installation.

Large steam jet ejectors, while based on a relatively old principle, are today utilized to produce refrigeration. In its new dress, a jet of live steam at 2 psig or more darting in a properly-designed venturi tube greatly reduces the pressure over warm water. The jet also removes water vapor, thereby maintaining the vacuum and lowering the temperature of the water to that at which it boils, which may be as low as 35° F. Such coolers are in use today in many industries, such as:

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REFINER AUTHORS and Other Personalities

Information, formal and otherwise, about the men who write for PETROLEUM REFINER as well as others prominent in the industry.

H. F. Peters E. T. Horridge

Hydrocarbon Author

WORKING on a summer cottage in southern New Jersey gives H. F. Peters, author of the article, "Partial Enthalpies of Light Hydrocarbons," which starts on page 109 of this month's issue of PETROLEUM REFINER, a chance to get away from it all. Raising two girls and a boy keeps him pretty busy also.

A graduate of the Cooper Union School of Engineering with a degree in chemical engineering, Peters was associated with Caye Construction Company for five years, working on construction of sewage treatment plants, hospitals and similar projects in and around New York City. In 1942 he joined E. I. Du Pont de Nemours and Company, Inc. as a field engineer on construction of the Wabash River Ordnance Works in Clinton, Ind.

Switching over to mechanical engineering, he was employed by the M. W. Kellogg Company in its mechanical engineering division for two years. Peters then transferred to Kellogg's gas process and light hydrocarbon division as a process design engineer. Since 1948 he has worked with Scientific Design Company, Inc. on chemical and petrochemical plants. Besides doing that, he is an electrical engineering consultant on industrial applications of high frequency induction and dielectric heating.

Shell Man Writes

E. T. HORRIDGE, author of "Economics of Motor Voltage Selection," Part I of which starts on page 133 joined Shell Oil Company, Inc., in 1941, as a member of the engineering department of the company's Houston refinery. In 1945 he was transferred to the construction department to assist in the consummation of an extensive expansion program for the refinery's electric power generating and distribution facilities.

Early in 1948 Horridge was assigned to the utilities department to participate in the operation of the completed power generating and distribution facilities and to collaborate with the plant's engineering and construction departments on electrical design and construction problems.

Organist-Chemist Offers Handy Index

W. L. Bolles, via the indexing route, has come into PR's columns again, this time more than a year after his "Measurement of Gas Temperatures by Means of Thermocouples" appeared. Bolles, who is a process engineer at the Texas City plant of Monsanto Chemical Company, has been working "for almost five years, now" on the article "Decimal Classification System for Chemical Engineering" which starts on page 140.

The classification system as it now stands, asserts Bill, "has gone through ten major revisions and as long as it is now, it ought to last a lifetime." After it is published, "I don't intend fooling with it any more," the author declares. So improvements, if any, apparently will have to come from his public.

Bolles, who was with Socony-Vacuum Oil Companies four years in both field research and research and development, has been a Monsanto man for better than two years and helped re-design the Texas City styrene plant after the Texas City disaster in 1947. He has been using the indexing system which he currently presents "with considerable success on my own files for several years" and "I have passed out several dozen copies to interested parties in Socony-Vacuum and Monsanto, many of whom have adopted the system for their own files."

Its use has not been without a jibe or two at the author who reports that "one of the boys in the office says that the title of the article should be 'How to Lose Things Systematically.'"

But enough of the article and more about the author:

Bolles received his B. S. degree in chemical engineering in 1941 from Washington University and his M.S. in chemical engineering from the University of Missouri two years later.

He now lives in La Marque, which is a next-door neighbor to Texas City, and he and the Mrs. have a blond, blue-eyed daughter, Gloria, 3 years old and a son born last March.

Incidentally, Bolles is a photography and radio expert of sorts and another of his special interests is piano and organ playing. As shown by the accompanying photo, he serves as organist at the Trinity Lutheran Church, La Marque.

W. L. BOLLES

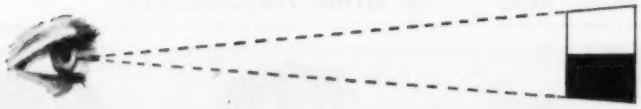
Ames and Tabbert Contribute Article

CO-AUTHORS of the article, "Ethane and Propane Separation Greatly Simplified at Dubach", beginning on page 117, are C. B. Ames and T. D. Tabbert, Fish Engineering Corporation, Houston.

C. B. Ames, vice president of Fish Engineering, was a member of the engineering staff of Stearns-Roger Manufacturing Company for 12 years, before joining Fish when it organized in 1946. He was in charge of the engineering and construction on the initial compressor stations and dehydration plants of Tennessee Gas & Transmission Company in 1943-44. Ames has taken part in the design and engineering of numerous gasoline and other similar plants during his 15 years in the oil and gas industry.

Ames has been flying airplanes for the past ten years—both as a hobby and for business purposes. As a matter of fact, the Ames family, particularly the youngsters (three boys), are not adverse to holiday excursions by air to the Rocky Mountains and the West Coast.

Currently he visits construction projects flying the company's 4-place Beech-



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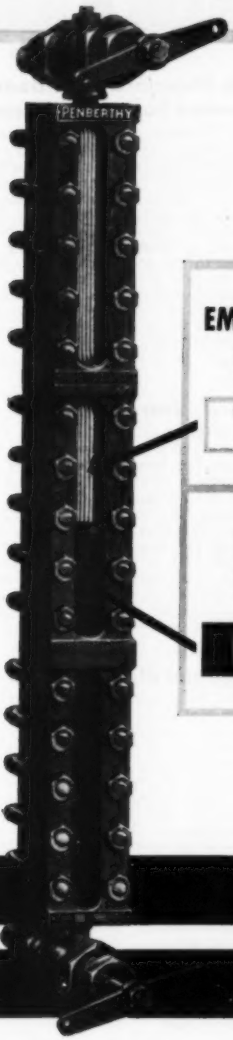

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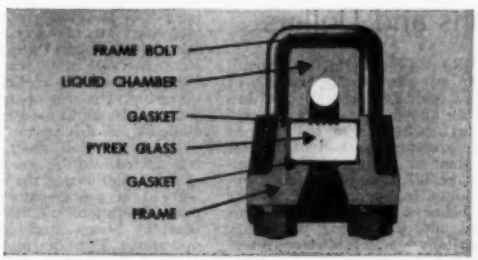

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PENBERTHY Reflex

DROP FORGED STEEL · LIQUID LEVEL GAGES

W. T. BRYANT T. D. TABBERT C. B. AMES JAMES C. STOPFORD

craft Bonanza. He likes a good tailwind to help things along. A strong proponent of safety first, Ames says if the pilot treats his ship properly, it will return the favor.

Tom D. Tabbert, process engineer of Fish Engineering, was born in the famous city of Milwaukee, attended high school there and is a graduate of the University of Wisconsin, 1941, in chemical engineering.

Tabbert started for Houston when he joined the gas-gasoline division of Shell Oil Company in Tulsa. After several years in process design and plant operation, he left in 1944 to enter the employ of Fluor Corporation, Ltd. as a process engineer in the firm's Kansas City office. Later he was transferred to the home office in Los Angeles. In 1947 he became a member of the engineering department of Fish Engineering Corporation—in Houston.

Tabbert says that once upon a time he liked sports—bowling, swimming, skiing, etc., in addition to process engineering work, but now there is absolutely no time for such items—he is tied up full time with Mark Tabbert, age two years.

Gallons and Dollars

W. T. BRYANT, general superintendent of the gas-gasoline department of American Republics Corporation, Houston, is better known to his associates and friends throughout the industry as "Doc." He presents the story of the new gasoline plant at Silsbee, Texas beginning on page 127. One of the most important things in operating a gasoline plant, he believes, is getting the gallons in the tank and then getting the money for the gallons — which under present market conditions, involves a neat bag bag of tricks.

Doc is a Texan, having been born in Hillsboro. He was graduated from Texas A.&M. College with a bachelor of science degree in chemical engineering. Then at the graduate school at the University of Illinois he received his master's degree, also in chemical engineering.

A little tired of studying, Doc went to work in the petroleum industry. One of his jobs was as engineer in charge of plant operation for Seaboard-Tidewater. And the East Texas field is not a stranger to Doc—he was around to help build the Hercules gasoline plant at Kilgore. Over in Shreveport, he worked as chemist for Louisiana Oil Refining Company and later became superintendent of the plant.

Doc and Mrs. Bryant have one youngster, William B. Bryant, at the Wood River refinery of Shell Oil Company, Inc.

For his favorite recreation, Doc says he prefers salt water fishing. His favorite meals are home-cooked and they seem just a little bit better when topped with a good cigar.

Bull Gang Vet Does an Article

BACK in 1936, a tall, lean young fellow sweated on the bull gang in the Deer Park refinery of Shell Oil Company. That was James C. (Jimmy) Stopford, process engineer for Delta Engineering Corporation, author of "Two Absorption Plans Use Existing Equipment from Third", which starts on page 123.

Stopford's family moved to Houston from New Jersey when he was two years old. After attending grammar and high school in Houston, Stopford enrolled in Rice Institute and was graduated in 1932, bachelor of science, chemical engineering. The rest of the depression he weathered out at odd jobs, which included truck driving in New York.

From the bull gang, Stopford was transferred into the research department of Shell, and during the next three years worked at process research and pilot plant operation. Transferred a second time, he became technical assistant in operations. Then during the next several years, he worked in the various departments throughout the plant. In 1943 he was transferred to the technological department of Shell's New York offices, where he remained until 1947.

Stopford joined Delta Engineering Corporation during its organization in 1947.

He is the proud father of a two-months-old daughter, who, he says, has eliminated any sail-boating he might want to do. However, he does get in an occasional round of handball at the "Y".

Ohio Standard President Becomes Board Chairman

W. T. Holliday, president of Standard Oil Company (Ohio), has been elected chairman of the board of directors of the company. Former executive vice president Clyde T. Foster became president in the same action by the board. Samuel H. Elliott, vice president in charge of transportation; has been elected to the board of directors to succeed the late A. M. Maxwell.

Holliday will continue in active charge of matters of major policy affecting the parent company and its subsidiaries. Foster will take over executive details and have direct charge of company operations.

Luis de Florez Elected

Rear Admiral Luis de Florez, USNR, inventor and developer of aircraft special devices, has been elected to the board of directors of G. M. Giannini & Company, Inc., Pasedana, Calif.

During World War II, Admiral de Florez served as Director of the Special Devices Division of the Bureau of Aeronautics, and as Assistant Chief of the Office of Research and Inventions. He is a winner of the Robert J. Collier Trophy for his wartime contribution to safe and rapid training of combat pilots and crews.

Magnolia Men Honored

John W. Newton, vice president, director and manager of refining for Magnolia Petroleum Company, was initiated into the Texas Delta Chapter of Tau Beta Pi, honorary professional society for engineers, at a ceremony on April 25 at Texas A. & M. College. Following the initiation, he presented the dinner speech. Vice president of the board of directors of the college, Newton was a member of the faculty for two years following his 1912 graduation.

E. C. Daigle, chief chemist with Magnolia Petroleum Company in Beaumont, has been elected chairman-elect of the Texas-Louisiana Gulf section of the American Chemical Society. At the same time Eugene Reeves, supervisory process engineer with Magnolia, was elected treasurer. They will assume the posts in July.

McKee Engineering Service

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McKEE is currently engaged in engineering projects for the Petroleum and Iron and Steel industries in the United States and *twelve foreign countries.**

The broad facilities and ample resources of the McKee organization enable us to undertake all phases of plant design, engineering, material procurement and construction of refinery projects of any size in any domestic or foreign location.

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Maintenance and Operation—

HOW TO DO IT

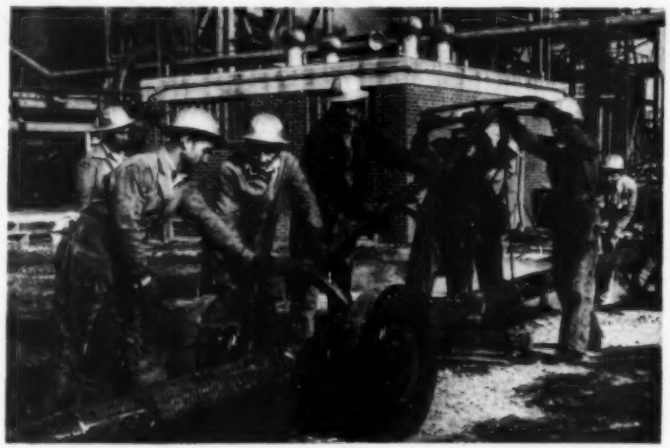
HOW—

Pipe Dolly Aids in Plant Maintenance

USE of pipe breakdown dolly being demonstrated by the crew in the photograph is a time and labor-saving piece of equipment that was built in the Baytown refinery shop of Humble Oil & Refining Company. Most of the material used in construction of the dolly is plant salvage.

The dolly consists of two automobile wheels and tires mounted on a curved axle. A lever or tongue is securely welded to the center of the axle on the underside. The lever action of the tongue is derived by extending the head end about six inches beyond the axle. The free end of the lever is equipped with welded handlebars. To lift a length of heavy pipe, the head end of the lever is chained to the pipe with the free-end raised; then the free-end is pulled down by the two men on the handlebars, which raises the pipe off the ground so that it can be blocked up. Then the free end of the lever is raised, the head end fastened closer to the pipe, and the process repeated until the pipe has been jacked high enough to be moved by the dolly to the location in the plant where it is to be installed.

It will be noted that one man is using a rope for snubbing the free end of the lever to the pipe being lifted. This is an important safety measure toward preventing possible injury to the two men on the handlebars and the man who locks the pipe with a length of chain to the dolly near the center of the lever. The chain secures the pipe to the dolly after it has been raised to the desired level for moving to the installation location.



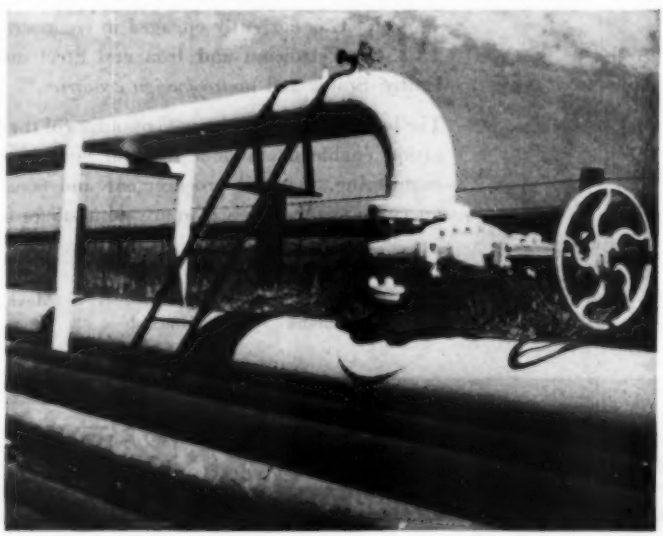
Regardless of the type equipment in use, safety is a prime requisite. In the background of this picture one of the crew is holding a snubbing rope, which is tied to the free end of the lever. This action prevents possible injury to the crew members.

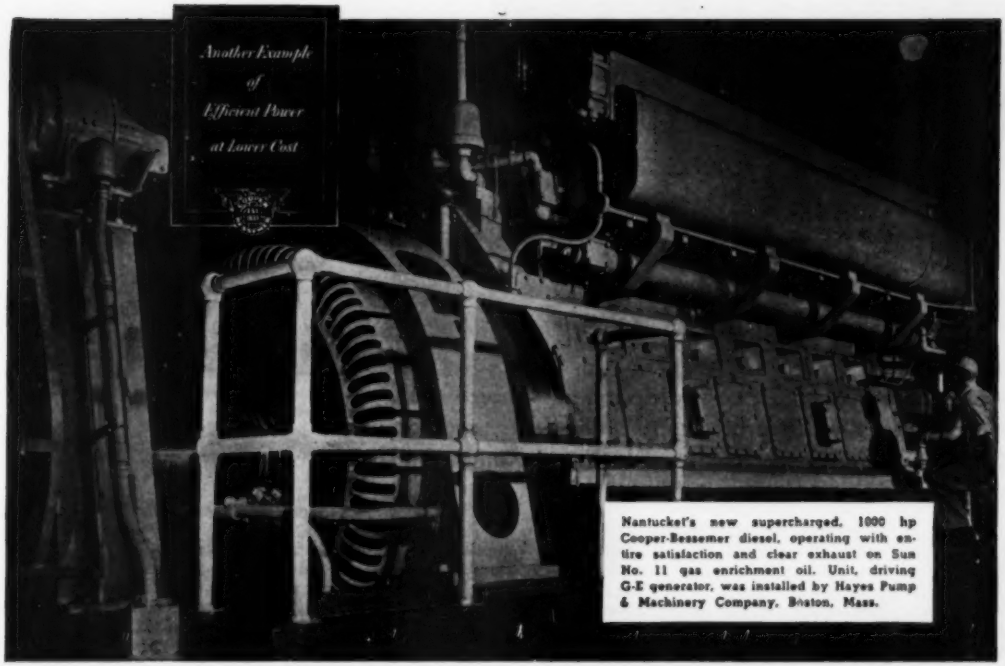
HOW—

A Steel Platform Ladder Helps Inspection Work

A LADDER with a platform at a convenient height so that a workman can work without leaning against the pipe or assuming some other uncomfortable positions, is a safe, easy method of inspecting gages or installing instruments for inspecting the pressure system.

The ladder, shown in the photograph is steel pipe with rods as rungs. The sides of the top extend into hooks, which slip over the top of the line. The platform is a single sheet of heavy steel, supported by the sides of the ladder and straps.





Nantucket's new supercharged, 1000 hp Cooper-Bessemer diesel, operating with entire satisfaction and clear exhaust on Sun No. 11 gas enrichment oil. Unit, driving G-E generator, was installed by Hayes Pump & Machinery Company, Boston, Mass.

Nantucket's New Diesel Burns Heavy Fuel

SAVES $11,950 A YEAR!

NANTUCKET Gas & Electric Company urgently needed additional power capacity. Their aging steam turbine plant was hardly adequate. After carefully weighing all factors, a supercharged Cooper-Bessemer diesel was picked for the job!

For one thing, due to existing fuel storage facilities and the island's transportation problems, it would be a tremendous advantage to fuel the diesel with the same, low-cost heavy oil burned in the turbine boiler and used as an enriching agent in gas-making. Cooper-Bessemers had already demonstrated their ability to operate efficiently, reliably on Bunker C and other heavy oils.

Secondly, extremely close speed regulation was essential. The new unit was to be paralleled with the turbine generators and was to power an aircraft radio beam requiring exceptional cyclic control. Here again Cooper-Bessemers offered proved performance.

These and other problems in this unusual installation, *including the elimination of smoke*, despite the heavy fuel, were overcome right from the start. Consequently, the new engine went into service at once. And, by burning heavy fuel instead of regular diesel fuel, it is estimated that the new Cooper-Bessemer will save $11,950 a year at present fuel rates.

Whether your power need is ordinary or unusual, if you want to know how you can cut your power costs year in, year out, check with Cooper-Bessemer.

The
Cooper-Bessemer
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Ethyl-developed research methods useful to refiners

Here are some of the specially designed research tools used by the Ethyl Laboratories to study fuels, engines, lubricants and antiknock compounds that you might find helpful in your own research efforts.

THE DEVELOPMENT of experimental equipment and procedures that will produce reliable data is essential to progress in fuels and engines. During the past 26 years an important activity of the Ethyl Laboratories has been the development of procedures for research on problems relating to engines, fuels, antiknock compounds, and lubricating oils.

One of the earliest contributions made by Ethyl was the octane number scale, and this was followed by the development of the first generally distributed knock testing engine. Many other procedures developed by Ethyl can prove equally useful to the refiner who is desirous to obtain:

- **a.** More effective application of his products to the range of conditions encountered in service.
- **b.** A better understanding of the relationships between petroleum products and engines.

Examples of procedures developed at Ethyl Laboratories:

1. Duplicating "road" operation in the laboratory. The duplication in the laboratory of the road performance of engines, requires a schedule of operation simulating the variations in engine speed and load which are characteristic of road operation. Different types of mechanisms—employing pneumatic, electrical and electronic principles—have been devised for reproducing these variations. Fig. 1 shows one type of automatic mechanism which employs a perforated "piano" roll to operate both dynamometer and engine controls to simulate any desired pattern of road operation. For example, Fig. 2 shows how closely the effect of lubricating-oil type on valve life as determined on the road may be duplicated in the laboratory.

2. Multicylinder engine "knocking" research in single-cylinder engines. Some years ago Ethyl engineers measured the variations in the distribution of fuel to the cylinders of engines. It was shown that an irregular pattern of fuel distribution prevailed and that this had a pronounced effect on the knocking tendency of engines and on the relative performance of fuels of different composition. Ethyl engineers developed a bled manifold (Fig. 3) for use with single-cylinder knock testing engines. This manifold permits, under steady operation, the simulation of transient conditions in respect to fuel distribution existing in multi-cylinder engines.

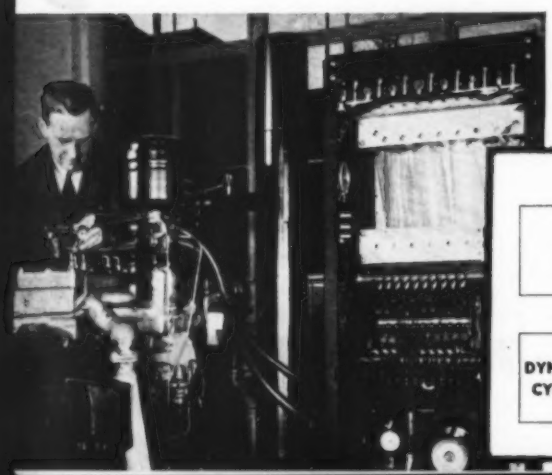
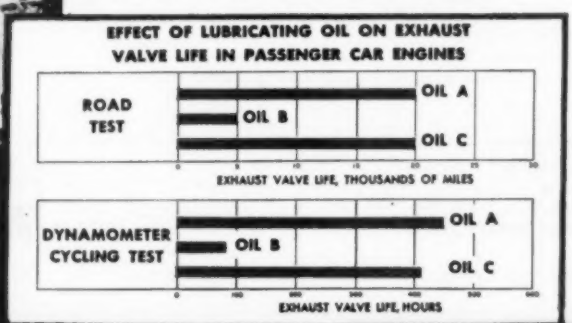


Fig. 1. "Plastic Highway." This special equipment employs a perforated plastic tape for the control of engine speed and torque simulating indoors the variations found in actual road service.

Fig. 2. Chart below shows that when engines on dynamometers are subjected to the same program of variations in speed and load as encountered in road service, comparable performance is obtained.



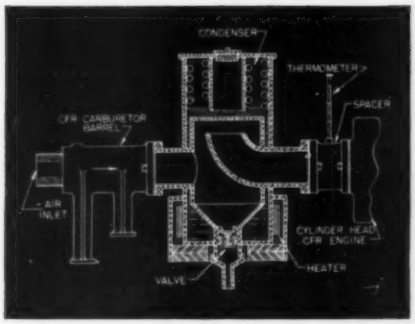


Fig. 3. Cross-section of bled manifold for "knocking" research on single-cylinder engines under conditions simulating unequal fuel distribution encountered in multi-cylinder engines.

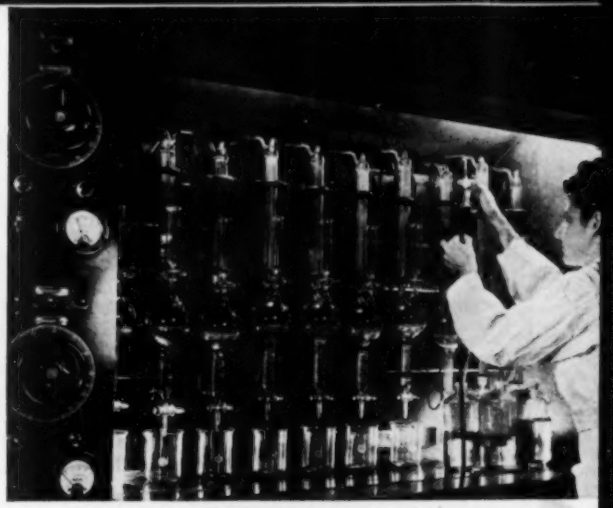


Fig. 4. Apparatus used to determine the tetraethyllead content of gasoline . . . an Ethyl development now widely used.

3. Procedures in analytical chemistry. Control of antiknock quality requires accurate analytical procedures. An example of progress in this field is the development of an accurate and rapid method, now widely used, for the determination of the tetraethyllead content of gasoline (Fig. 4).

4. Testing engine metals under simulated operating conditions. The Ethyl Laboratories designed and built for the U. S. Army Air Forces a special furnace (Fig. 5), which subjects samples of metals used for engine construction to controlled tensile stress under alternate heating and cooling in an atmosphere of combustion products similar to that in engines. This equipment is used by Ethyl and other laboratories for the testing of steels for valves and other engine parts.

Since 1923 it has been Ethyl's objective to render a complete antiknock service. The development of research equipment and procedures is just one part of the over-all Ethyl research effort designed to improve "Ethyl" antiknock compound and to aid refiners in the economical production of satisfactory gasoline.

This message is the fourteenth in a series dealing with problems encountered by refiners in producing gasoline for today's and tomorrow's engines, and the contribution of the Ethyl Corporation to their solution. Future messages will discuss other phases of these problems.

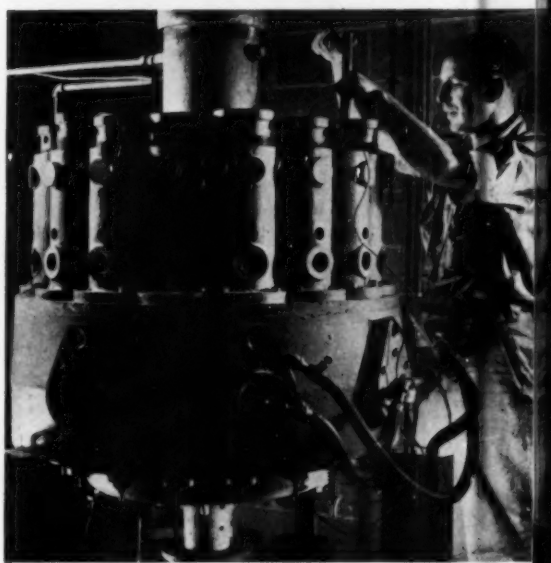


Fig. 5. Furnace developed by Ethyl for the testing of metals employed in engine construction under conditions comparable to those found in actual engine service.

SINCE 1923 — *Continuous Research to Provide Better Antiknock Service*

ETHYL CORPORATION

RESEARCH LABORATORIES

DETROIT, MICHIGAN . . . 1600 WEST EIGHT MILE ROAD

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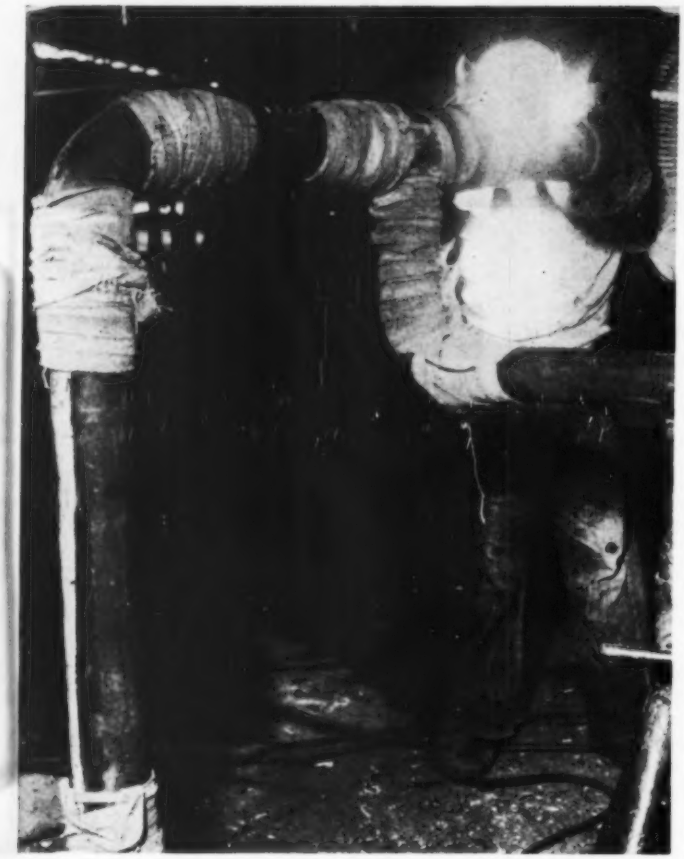
HOW—

New Procedure Facilitates Welding 4-6 Chrome Pipe for Refinery



This welder is using a new procedure for welding 4-6 chrome pipe, which was devised by Houston Pipe and Steel, Inc. The method employs preheating with oxyacetylene to bring the temperature of the joint to 600-800° F. for welding. Then temperature of the joint is raised to 1200-1350° F. and the joint wrapped with asbestos tape to a minimum of one inch and cooled to room temperature. According to certified laboratory tests, the weld showed ultimate tensile strength of 73,200 psi. The firm reported that it used the procedure for welding chrome pipe for a large oil refinery and the job was completed satisfactorily, quickly, and inexpensively.

A NEW procedure for welding 4-6 chrome pipe has been devised by Houston Pipe and Steel, Inc., Houston, for use in the welding of chrome pipe being fabricated for installation in a large oil refinery. According to M. Van Blaircom, chief engineer of the company, the new technique does not make the weld metal so hard that it becomes brittle. Laboratory test certified by Shilstone Testing Laboratory of Houston, showed very desirable results. The weld showed an ultimate tensile strength of 73,200 psi., and a satisfactory rating on a 180-degree root bend. The Brinell hardness in the weld was indicated as 248, and in the pipe 174. A Charpy impact notched test, made in the weld metal at 70 degrees, was 49.0 foot-pounds. Chemical analysis of the weld metal showed 7.73 percent chrome in the weld and 4.53 percent chrome in the pipe. Van Blaircom stated that where greater ductility and elongation was required, a furnace anneal at 1600 degrees was given after the pipe had cooled, which resulted in an average elongation of 40 percent in 2 inches.

Preheating

"The excellent test results proved without a doubt the practibility of our new procedure," he declared. "We used it throughout the production of the chrome pipe and the lot was completed satisfactorily, quickly, and inexpensively."

In the new process, a large preheating tip with oxyacetylene was used first to bring the temperature of the joint up to 600-800° and keep it there while the welding was done using General Electric chrome electrode Type W-1502 (ASTM-AWS Spec. No. E-502). After this, the temperature was raised to 1200-1350° and the joint was wrapped with asbestos tape to a minimum thickness of 1 inch and cooled to room temperature.

HOW TO—

Use Steam Line Insulation Efficiently

REGARDLESS of the thickness used, a surprisingly large loss of steam superheat may occur if the diameter of the steam line is too large for the desired steam flow conditions, according to the Magnesia Insulation Manufacturers Association.

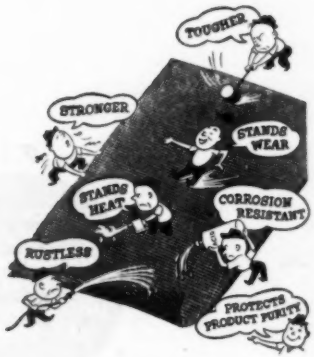
Such a case occurred recently in a plant where an outdoor line, 6 inches in diameter and 925 feet long, with an ambient air temperature of 80°F., was used to transmit superheated steam at 250 psi. and 600° F. This line was insulated with 2 5/16-inch-thick, 85-percent magnesia pipe insulation. However, the steam temperature at the end of the line was only 450°F.

Analysis indicated that the steam velocity in the line was only a little over 1300 feet per minute, whereas it could well have been between 6000 and 10,000 feet per minute without excessive pressure drop. The result was that, due to the relatively large size of the pipe for the steam quantity handled, there was a large drop in superheat. Also, the investigation showed that simply increasing the amount of insulation would have no appreciable effect on the extent of superheat loss. The recommendation was that it would be cheaper and more satisfactory to replace the 6-inch line with a 1½ or 2-inch pipe, insulated with 3-in-thick, 85-percent magnesia.

Design

Literature on correct procedure for piping system design, recommended pipe sizes, steam velocities, flow conditions, etc., may be obtained from valve and piping manufacturers and fabricators. The information is available in the various engineering handbooks, also. Literature on recommended thicknesses of insulation can be obtained from the Magnesia Insulation Manufacturers Association, Washington 4, D. C.

This Screen and Filter Cloth will do you a world of good!



What other wire cloth offers you so many life-lengthening properties as that made of Monel*, Nickel or Inconel*.

These metals are called "task metals." And for good reason! They're rustless . . . corrosion-resisting . . . strong . . . tough. They stand abrasive wear. They endure extreme temperatures. They protect product purity.

All meshes and weaves are available for your filtering, screening or conveying needs.

Monel, Nickel and Inconel wire cloth is easy to join, too. Do it by brazing, soldering or welding. You get strong joints that do not deteriorate in service.

The next time you replace or install wire cloth, investigate the "task metals." Thanks to easy working qualities, weavers produce wire cloth of Monel, Nickel and Inconel at prices comparable to what you now pay for cloth of less durable metal. *Fine weaves of Monel often cost less!*

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THE MONTH in the INDUSTRY

* * *

Railroad Uses of Diesel Fuels, Lubricants Increase

Railroad use of diesel fuel oil will increase approximately 36 percent in 1949 over 1948, 27 percent in 1950 and 21 percent in 1951 according to a study made by Socony-Vacuum Oil Company, Inc. Consumption of lubricants by diesel locomotives will increase at about the same rate, A. J. McIntosh, economist for the company, said. In 1948 diesel use was estimated at 30 million barrels and lubricant use at 330,000 barrels.

"I feel sure that if the railroads continue to find the diesel engine as efficient as they have in the past, that the railroads and the petroleum industry will work out some satisfactory solution to provide this supply at a price commensurate with the value of the product," McIntosh stated.

Shell Union Oil Elects Four New Board Members

Shell Union Oil Corporation has elected four new directors, raising the board membership to 18. The new directors are Cason J. Callaway, Stanley W. Duhig, H. Bloemgarten and J. W. Boyle.

Owner of the Blue Springs Farm in Hamilton, Ga., and Callaway is a director of U. S. Steel Corporation, Chemical Bank and Trust Company of Georgia.

Vice president and treasurer of Shell Union since 1938, Duhig has been associated with the Shell group since 1910.

Bloemgarten is managing director of Royal Dutch Petroleum Company and Batavian Petroleum Company and a director of Shell Caribbean Petroleum Company.

Boyle, with Shell since 1922, is also a director of The Shell Transport and Trading Company and Shell Caribbean.

Du Pont Holds Open House

E. I. Du Pont de Nemours and Company, Inc., held open house April 1 for officials of the petroleum industry in the Gulf Coast area to inspect facilities of the company's petroleum chemicals laboratory in Houston. The laboratory was established to serve oil refiners in Texas, Louisiana and New Mexico in connection with their use of oil chemicals marketed by Du Pont.

Bareco Names Clary

B. H. Clary has been elected a vice president and a member of the board of Bareco Oil Company. He succeeds the late H. V. Blaxter.

Calendar of Meetings

MAY	
8-12	American Institute of Chemical Engineers, Regional Meeting, Tulsa.
9-10	American Petroleum Institute, Division of Marketing, St. Louis, Jefferson Hotel.
9-10	American Gas Association, Natural Gas Department, Spring Meeting, French Lick, French Lick Springs Hotel.
9-11	Liquefied Petroleum Gas Association, Annual Convention and Trade Show, Chicago, Palmer House.
10-12	Interstate Oil Compact Commission, Jacksonville, Roosevelt Hotel.
12-13	Instrument Society of America, Annual Spring Meeting, Toronto, Canada, Royal York Hotel.
12-13	American Gas Association, Executive Conference, San Francisco, Fairmount Hotel.
16-19	National Fire Protection Association, San Francisco, Fairmont Hotel.
16-20	Oil Heat Institute of America, Annual Meeting, Boston, Statler Hotel.
17-19	Pennsylvania Gas Association, Annual Convention, Wernersville, Galen Hall.
23-25	American Gas Association Production and Chemical Conference, New York, Hotel New Yorker.
26	Society of Automotive Engineers, Diesel Engine, New York, Engineering Societies Building.
26-27	The Natural Gas and Petroleum Association of Canada, Annual Meeting, London, Ontario, Hotel London.
30 to June 1	Fourth Annual Short Course in Gas Technology, Kingsville, Texas, A & I College.
JUNE	
5-10	Society of Automotive Engineers, Summer Meeting.
12-16	Instrument Society of America, Annual Convention, St. Louis, Municipal Auditorium.
16-20	Canadian Gas Association, Annual Convention, Lake of Bays, Ontario, Canada, Bigwin Inn.
17-20	American Gas Association, Annual Convention, Chicago.
24-25	Michigan Gas Association, Annual Convention, Mackinac Island, Grand Hotel.
24-28	National Safety Council, Chicago, Morrison Hotel.
27-30	The American Society of Mechanical Engineers, Semi-Annual Meeting, San Francisco.
27 to July 1	American Society for Testing Materials, Annual Meeting, Atlantic City, Haddon Hall, Hotel Chalfont.
AUG.	
17-31	United Nations Scientific Conference on Conservation and Utilization of Resources, Lake Success.
SEPT.	
12-16	Instrument Society of America, National Conference and Exhibit, St. Louis, Municipal Auditorium.
14-16	National Petroleum Association, Atlantic City, Hotel Traymore.
18-20	American Institute of Chemical Engineers, Montreal, Canada, Mt. Royal Hotel.
19-21	National Butane-Propane Association, St. Louis.
28-30	The American Society of Mechanical Engineers, Fall Meeting, Erie.

Robert Scholl Named to Esso Post, API Committee

Robert H. Scholl has been appointed general counsel of Esso Standard Oil Company. Associate general counsel since 1946, he succeeds Edwin S. Hall, who continues as vice president and director of the company.

Scholl

W. R. Boyd, Jr., president of the American Petroleum Institute, has named Scholl to membership on the American Petroleum Industries Committee to fill the vacancy caused when Hall relinquished his committee membership to undertake a special assignment with Esso.

"Weighted Index" Octane Number Offered by Phillips

A "weighted index" octane number is the best single test of the performance of motor fuel, according to R. C. Alden, director of research for Phillips Petroleum Company. This means "an averaging of proportioning of the Motor and Research octane numbers," he explained. "This weighting can be on a 50-50 basis between the two laboratory octane numbers." Actually, however, it was Phillips' opinion "that the Research octane number should receive more emphasis than the Motor octane number."

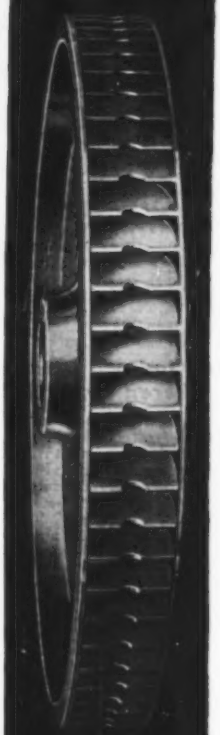
Claiming that the current stress on gasoline Research octane numbers and on "jump" is an over-emphasis of the actual technical facts, Alden said that "automobile engines cannot forget Motor octane numbers just because the oil industry wants to talk about Research octane numbers."

Motor fuel surveys show "that the Research octane number millenium has not arrived, at least in the central area of the United States," Alden said, and "it seems that there must be a lot of wishful thinking leading to the conclusion that Research octane number levels of 80 and 86 for housebrand and premium gasoline can be obtained overnight."

Indiana Standard Refinery Employes Win Safety Award

The distinguished service to safety award of the National Safety Council has been presented to employes of the Sugar Creek, Mo. refinery of Standard Oil Company (Indiana) for working al-

TERRY



BLADE PROTECTION

Made Possible by Nozzle Location

In the Terry Solid-Wheel Turbine, the steam enters the buckets from the top, not from the side of the wheel, as shown in the illustration above. This permits a one inch clearance on either side of the wheel. In addition, projecting rims on each side of the buckets prevent damage to the blades even though excessive thrust should tend to move the shaft.

This feature and others, as important, are described in detail in Bulletin S 116 which will be sent to you on request.

T-1178

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

THE MONTH...

most 14 months without loss of time or disabling injury because of accident.

The Sugar Creek safety record covered one year, one month, and 21 days from October 2, 1947, to November 23, 1948. During this time the 1237 employes worked 2,669,039 manhours without loss of time or disabling injury because of accident. This safety record represented a reduction in accident-frequency rate of 2.64 and a reduction in accident-severity rate of 4.48 over the previous corresponding period.

This is the second time a Standard refinery has met the requirements for the award. Whiting, Ind. refinery employes won the other award.

Dr. W. E. Hanford Elected Vice President of Kellogg

Dr. W. E. Hanford, director of petroleum and chemical research, has been elected a vice president of The M. W. Kellogg Company, the election taking place at the annual meeting of the company's board of directors. All other officers of the company, including M. W. Kellogg as board chairman and H. R. Austin as president, were re-elected.

Hanford

Nationally prominent in many fields of research, Dr. Hanford joined Kellogg in 1946, coming from General Aniline and Film Corporation where he was director of research. He was appointed to the newly created post of director of petroleum and chemical research in 1948.

New Product Development Unit Formed for Cyanamid

American Cyanamid Company has formed a new product development department with George W. Russell manager. One of its functions will be to determine whether there are economic uses for selected products which have been developed in Cyanamid's research laboratories, for which sales applications are not yet established. At present, most of the group's activity will be devoted to the evaluation of organic nitrogen compounds.

The group also will conduct market research on currently manufactured products, as well as those in the development stage.

Koppers Names Naylor

G. W. Naylor, formerly general manager of manufacturing for Sun Chemical Corporation, has been named manager of the development section, chemical division of Koppers Company, Inc., Pittsburgh.

He joined Sun Chemical in 1945, after a score of years with Sherwin-Williams Company, and was responsible for Sun's production, research and engineering. He is a graduate of Cornell.

NGAA Names James E. Pew President; Francis Edgar Rice Gets Hanlon Award

C. C. PRYOR, Associate Editor

Francis Edgar Rice, vice president, Phillips Petroleum Company, Bartlesville, Okla., was presented with the Hanlon Award, highest honor of the natural gasoline industry at the Natural Gasoline Association of America's 28th annual convention in Fort Worth, April 20-22.

Rice

Presentation of the award to Rice was made by C. R. Williams, vice president, The Chicago Corporation, Corpus Christi, and president of the NGAA. Rice is the thirteenth recipient of the award, which is presented each year by the NGAA for outstanding service to the natural gasoline and cycling industries. The award was given by E. I. Hanlon, president of the Hanlon Companies and chairman of the board of the National Bank of Tulsa.

New NGAA Officers

James E. Pew of Sun Oil Company, Philadelphia, was elected president of NGAA and John Atkins, The Parade Company, Shreveport, La.; John F. Lynch, La Gloria Corporation, Corpus Christi; T. S. Taggart, Standard Oil Company of California, San Francisco, and Albert H. Weil, United Gas Pipe Line Company, Shreveport, La. were elected vice presidents.

Memebrs of the Natural Gasoline Supply Men's Association also elected new officers as follows: J. N. McClure, Elliott Company, Tulsa, president, succeeding Roy R. Bush, Nordstrom Valve Company, Tulsa; L. L. Dresser, Dresser Engineering Company, Tulsa, vice president and Dallas S. Deem, American Air Filter Company, Tulsa, second vice president. M. E. Duncan, Johns-Manville Sales Corporation, Tulsa, was elected treasurer, and William F. Lowe, Tulsa, was reelected secretary.

Thirteen new directors were elected by the supply men's group for two year terms, as follows: M. W. Conn, Perco Division, Phillips Petroleum Company, Bartlesville; J. N. McClure, Elliott Company; E. P. Shelton, Chicago Bridge & Iron Works, Tulsa; George L. Gudenrath, Delta Engineering Corporation, Houston; M. H. Kotzebue, Gasoline Plant Construction Company, Houston; R. D. Ricketts, The Fish Engineering Corporation, Houston; M. H. Roths, Brown and Root, Inc., Houston; J. A. Mussler, Continental Supply Company, Dallas; J. L. Tullis, J. B. Beaird Company, Inc., Shreveport; E. C. Wise, General Electric Company, Dallas; W. H. Edwards, Superior Manufacturing Company, Amarillo, Texas; Ray T. Jenkins, The Marley Company, Inc., Kansas City, Mo., and Ray E. Miller, E. I. duPont deNemours and Company, Inc., Wilmington, Del.

NGAA Research Reports

First general session of the meeting was devoted to the scheduled reports made by chairman of the various NGAA research committees, which seek new technical standards for testing the light products of natural gasoline plants. Several of the reports dealt with the field testing of natural gases and studies of corrosion in gas-condensate wells. The reports included "The Accuracy of Low Temperature Fractional Analysis of Liquid Hydrocarbon Mixtures", A. J. Miller, Phillips Petroleum Company, chairman of the fractional analysis committee; "Tests for Determining the Liquid Content of Field Gases", W. H. Vaughn, Tide Water Associated Oil Company, chairman of the field gas testing committee; "Modifications in LPG Test Methods", H. A. Montgomery, Warren Petroleum Corporation, chairman of the Corrosion Research Project Committee, and "Report on NGAA Proposal to ASTM for 15-pound Rvp. Winter Motor Fuel", Kenneth Bottenberg, Phillips Petroleum Company, chairman of the motor fuel sub-committee.

Ralph Hock, reservoir engineer, Cotton Valley Operator's Committee, in his presentation, "Performance and Efficiency of Gas Cycling Operations", discussed the changes in reservior conditions during ten years of cycling and repressuring the Cotton Valley gas-condensate field. The latest developments in motor fuel trends were presented by C. H. Van Hartesveldt, Thompson Vita-Meter Corporation, in his address, Progress Report an Anti-Detonant Injection in Automotive Engines". Recent full-scale road tests in Ohio where small quantities of an alcohol-water mixture was injected into the fuel system to improve the anti-knock rating of the fuel were discussed.

"Trends of the Times" was the title of an address by Richard Wagner, president, The Chicago Corporation, on the broad economic and political trends and their effect on the national economy. (This address appears on page 89.) Howard Felt, vice president, Warren Petroleum Corporation, in his address, "Some Warnings for the LPG Manufacturer" discussed production trends and uses for liquefied petroleum gases. J. C. Harris, Stanolind Oil & Gas Company, outlined the highly successful job training program of his company in his presentation,

Sohio, Sun Collaborate In Pipe Line and New Company

A 1000-mile, 22-inch pipe line carrying crude from Texas, Arkansas, Louisiana and Mississippi to refineries in Ohio and Kentucky is to be constructed and operated by Mid-Valley Pipeline Company, organized last month. The Standard Oil Company (Ohio) and Sun Oil Company have made initial subscriptions in equal part to the capital stock of the company. Sohio has refineries at Toledo, Lima, and Cleveland, Ohio and Latonia, Ky. Sun's refinery is at Toledo.

The line will have a capacity of 140,000 barrels daily at the Lima terminus.

THE MONTH . . .

"Job Training to Increase Opportunities for Operating Personnel."

The Natural Gasoline Supply Men's Association entertained NGAA delegates with "Chuck Wagon" dinner and stage show in the Fort Worth North Side Coliseum.

Leader Given Award

Francis Edgar Rice, recipient of the Hanlon award, studied at Wooster College and finished his engineering education at Washington University, 1910. He came to Tulsa in 1917 as an engineer for a gasoline plant construction firm and later the same year joined Phillips Petroleum Company as a construction engineer. He became chief engineer of plant construction in a short time, was made general superintendent of gasoline plants in 1923, and has been vice president in charge of natural gas and gasoline operations since 1930. He is now a memebr of the board of directors and official in several subsidiary companies.

Rice's achievements were given in the citation. He was a leader in the development and use of the oil absorption process for making natural gasoline, and a pioneer in the superfractionation of natural gasoline, which opened a new source for ingredients of high-octane aviation fuels. His efforts were responsible in no small part for recognition of the superior quality of natural gasoline ingredients for motor fuel. Under his direction the first commercial plant to manufacture butadiene as a by-product of natural gas cracking operations was designed and built. He established the first research department devoted exclusively to the study of properties of natural gasoline and liquefied petroleum gases and by his leadership, initiative and organization ablity contributed greatly to the growth and technical progress of the natural gasoline industry.

Robert Vroom Promoted To Peabody Executive Post

Robert C. Vroom has been promoted to executive advisor and consultant with Peabody Engineering Corporation and will take part in all phases of the company's activities with particular attention to planning, procedure and overall policy. His headquarters will be in New York.

Vroom

Inventor of several pieces of equipment and patented devices relating to the combustion of fuels and allied subjects, Vroom was previously chief engineer. He is a graduate of Stevens Institute of Technology, holding a degree of master of engineering.

Engineers Move

Ehrhart and Arthur, Inc., engineers and constructors, have been located at 155 Montgomery Street, Room 709 Alexander Building, San Francisco, since February 15.

Bennett

Prutton

Mathieson Makes Changes In Operating Management

Mathieson Chemical Corporation has appointed Dr. Carl F. Prutton vice president-director of operations of all the company's plants and Arthur T. Bennett, vice president, has been placed in charge of the eight plants recently acquired from Southern Acid and Sulphur Company. R. B. Worthy was named vice president in charge of the plants acquired from Standard Wholesale Phosphate and Acid Works as well as the Saltville, Va. plant of which he has been manager. J. F. Newell became vice president and is to remain at Lake Charles, La., where he has been in charge of the alkali and ammonia plants.

Before joining Mathieson in 1948, Dr. Prutton was head of the Department of Chemistry and Chemical Engineering at Case School of Applied Science and a consultant to a number of chemical companies.

Government, NPC Disagree On Some Oil Policy Views

Although the government disagrees with some of the national oil policy views which the National Petroleum Council has presented to it, Secretary of the Interior J. A. Krug has said "these will be given every consideration" before the government takes any action. He urged the industry not "to avoid controversial issues" and invited it to make suggestions, particularly on submerged lands development.

Controversial matters include "proper handling of imports, adequate reserves of petroleum and products for national emergency and what looks like impasse in the tidelands controversy." Both the government and the council are in agreement with "operation of price in a free market, desirability of and necessity for tax provisions designed to fit peculiarities of oil exploration and production, maintenance of favorable conditions for capital formation and participation of U. S. nations in development of world oil resources."

Pan American Fellowships Continue for 1949-50 Year

Pan American Refining Corporation is to contiue its policy of granting graduate fellowships in chemistry and chemical engineering for the 1949-1950 academic year. No restrictions are placed on the university in its choice of a fellow except he must be a graduate student preferably within one year of his doctorate.

Fellowships in chemical engineering are being continued at the University of Illinois, Massachusetts Institute of Technology and Rice Institute. Chemistry fellowships are being continued at the University of Texas, Ohio State University and the University of Oklahoma.

California Standard Lowers Disabling Accident Rate

Establishment of a new, all-time low in the frequency rate of disabling accidents throughout its eight operating departments during 1948 has been announced by Standard Oil Company of California.

The rate was down 36 percent below the average of the past five years. Motor vehicle accidents, taken separately, were 14 percent below the average of the past five years.

There were no fatalities in any of the company's plants or facilities during the year.

Certificates of Safety Achievement are to be presented to five of the operating departments for reductions of 25 percent or more from their average industrial accident frequency rate of the past five years.

Superintendent Named

C. J. Tighe, recently named superintendent of the new gasoline plant of Stanolind Oil and Gas Company at Ulysses, Kan., previously had served as field project engineer at the plant site in charge of construction.

The installation is one of four new plants that Stanolind is placing in operation during the first six months of 1949. The others are natural gasoline plants at Powell, Wyo., and Sundown, Texas, and a cycling plant at Pettus, Texas.

Spencer Chemical Adds Robert Schramm to Staff

Robert W. Schramm has been added to the market research staff of Spencer Chemical Company with headquarters at 610 Dwight Building, Kansas City, Mo. He was employed by Carbide and Chemical Corporation before coming to Spencer.

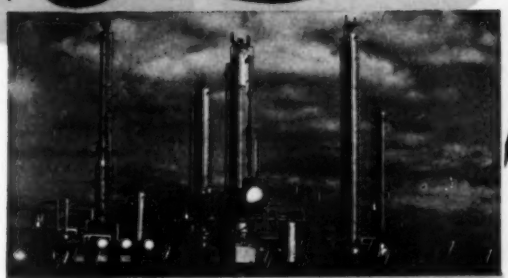
Schramm

The company is planning to construct additional production facilities at its Jayhawk Works at Pittsburg, Kans. Production capacity of anhydrous ammonia will be increased an estimated 30,000 to 40,000 tons annually, and production capacity of methanol will be increased slightly. Construction work will be done by Quaker Valley Constructors, Inc. Chemical Construction Corporation will be architect engineers on a portion of the project. Actual construction will begin shortly and the tentative completion date has been set for April, 1950.

Oil Movie Catalog Issued

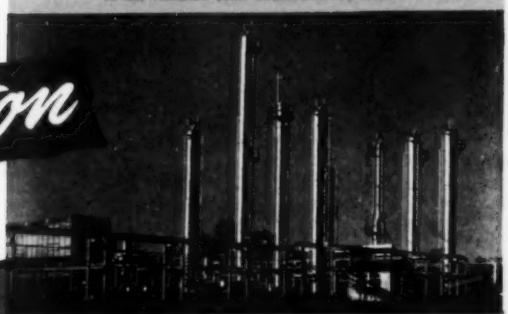
"Movies About Oil," a catalog of motion pictures about the oil industry which tells where and how they may be obtained, has been prepared and is being distributed by the Oil Industry Informa-

From Conception..



Now 35,000,000 cu. ft. natural gas processing plant of H. L. Hunt in the Harleton Field near Marshall, Texas.

To Completion



Now 50,000,000 cu. ft. natural gas processing plant of the Hunt Oil Company in the N. E. Lisbon Field near Lisbon, Louisiana.

The two new plants shown above were engineered, designed and constructed simultaneously, and both contain equipment which we salvaged in the dismantling of the Hunt Oil Company's absorption plant in the Long Lake Field near Palestine, Texas.

Yes—our service starts with the mere *idea* of a gas recovery, pressure maintenance or dehydration plant and continues through every phase of designing, engineering and construction to completion and full, efficient operation.

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THE MONTH...

tion Committee to oil companies, service clubs, colleges, schools and libraries. Letter-sized for easy filing, it lists movies available from oil companies, trade associations, educational associations and the government. In addition to telling how and where the films may be shown, the catalog gives the length of each film, whether or not it is in color and whether it is sound or silent. Address 50 West 50th, New York.

Chemical Group Elects

C. D. Goodale, Commercial Solvents Corporation, Terre Haute, Ind., has been elected president of the Commercial Chemical Development Association for the 1949-50 operating year.

Other officers are F. A. Soderberg, General Dyestuff Corporation, New York, vice president; C. W. Walton, Minnesota Mining and Manufacturing Company, St. Paul, Minn., treasurer; and G. O. Cragwall, Charles Pfizer and Company, Inc., Brooklyn, executive secretary. Directors include J. H. Boyd, consultant, New York; John B. Calkin, University of Maine, Orono, Maine; A. G. Fisher, Jr., U. S. Industrial Chemicals Company, Inc., New York; and W. B. Plummer, Indoil Chemical Company, Chicago.

Jack Anderson Promoted

Jack Anderson has been promoted by Standard Oil Company (Indiana) to assistant general foreman of the vapor recovery and polymerization units at its Sugar Creek, Mo., refinery. Graduating from the University of Oklahoma in 1943 with a chemical engineering degree, he has been with Standard since 1945, serving in the engineering division.

Two Standard Subsidiaries Appoint Vice Presidents

F. W. Mayer has been appointed vice president of California Refining Company. Starting his career with Standard Oil Company of California and its subsidiaries in 1914, he has been secretary and treasurer of California Refining since its organization in 1946, when it took over the facilities and operations of the Barber, N. J., refinery.

Mayer

H. H. Brereton, named vice president of The California Oil Company, joined California Standard and its subsidiaries in 1921. He is also secretary and treasurer of California Oil.

High-Compression Gasoline

A new premium gasoline which "will provide anti-knock performance in the new high-compression automobile engines and will give maximum efficient performance in older motors," has been announced by Standard Oil Company of California.

Standard has increased its wholesale price for this "Chevron Supreme" by one-half cent a gallon with no change in the wholesale price of the company's regular gasoline.

New Barreling Plant Opened

Douglas Oil Company of California began operations recently at its new barreling plant shown above. Located at the company's Clearwater, Calif., refinery, the plant is capable of handling 2000 barrels in 12 hours. Designed and built by the engineering staff of Douglas at a cost of $60,000, the plant is considered to be one of the most modern on the West Coast. L. A. Whitlock, director of refining, is in charge of all plant operations.

J. S. Leach Is Director

J. Sayles Leach has been elected a director of The Texas Company. A vice president since 1938, he started with the company as a bookkeeper in 1916 and served as salesman and district sales superintendent before coming to the Houston office in 1927.

Letcher Named Director

B. W. Letcher has been elected to the directorate of Standard Oil Company of California. With Standard since 1911, when he went to work as a clerk in the manufacturing department, he later became chief clerk in the general office, then assistant general auditor and in 1926 was made general auditor. He was elected secretary and comptroller in 1940 and a vice president in 1944.

Houston Office Opened

Project Construction Corporation, New York, has opened a Houston office at 201 Heights State Bank Building, 3620 Washington Avenue. The office will function as a sales and estimating office for petroleum refinery construction contracts, specializing in re-vamping and modernization programs. A. B. McClelland, Jr. and Earl Smith will be engineering sales representatives.

Gas Turbines Are Tested

Tennessee Gas Transmission Company is testing the possibilities of gas turbines with high output and high efficiency as prime movers for long distance transmission of natural gas. The turbine is to be installed in a line near Moorehead, Ky., to drive a centrifugal compressor. Expected to develop 5500 hp., the unit was built by Clark Brothers Company and Frederic Flander, Inc.

Gordon Kiddoo Establishes New York Consultant Office

Gordon Kiddoo has opened offices at 10 Fifth Avenue, New York 11, doing consultant work. He specializes in synthesis gas production; synthesis of fuels and chemicals from natural gas, oil and coal; oxygen production; fluidization of solids; gasification and utilization of coal; and pilot plant design and operation.

For several years he was associated with Hydrocarbon Research, Inc. Kiddoo was in charge of operations at the Montebello Laboratory of The Texas Company before moving to the New York office of the technical and research division of the company.

Corrosion Leaders Receive NACE Achievement Awards

In recognition of his achievement in the field of corrosion science, Dr. R. B. Mears, manager of the research laboratory of Carnegie-Illinois Steel Corporation last month was presented the 1949 Willis Rodney Whitney Award at the National Association of Corrosion Engineers annual meeting in Cleveland, Ohio. He is incoming president of the association.

F. L. La Que, in charge of the corrosion engineering section of International Nickel Company, Inc., was presented the 1949 Frank Newman Speller Award in recognition of his achievement in the field of engineering. He is past president of NACE.

Accident Rates Reduced

Although 1948 computations covered 18,445 more employes than in the previous year, the frequency rate of disabling injuries (number per 1 million hours worked) dropped 6.76 percent in the petroleum industry, the API has reported. This is the third decrease since 1942. There also was a 13 percent decrease in severity rate (number of days lost per 1000 hours worked). Fatalities

AL.

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By Robert H. Selltitz

Electrically minded Americans have nged the nation's electricity makers into biggest power expansion program the d has ever seen.

imbnail measures of its magnitude: to U. S. power making facilities ar 1939 are by themselves greater ombined generating capacity of Great Britain. New capacity completed in the next three es as much as has been tricity was discovered. rdstick: The $8.5 ty-making com- spend on ex- period is penditure rogram, spent over orld he

The Wall Street Journal, February 21, 1949

10%

The power generating facilities designed and constructed by Stone & Webster Engineering Corporation through the years total over 6,000,000 kilowatts, equivalent to one-tenth of the total generating capacity of all electrical utilities in the United States.

Work of the Corporation currently in progress for leaders in the industrial and public utilities field in all parts of the country will increase this total over 2,000,000 kilowatts.

STONE & WEBSTER ENGINEERING CORPORATION

A SUBSIDIARY OF STONE & WEBSTER, INC.

THE MONTH . . .

and permanent-total disabilities for 1948 amounted to the equivalent of 24.8 per 100,000 employes, a 19.2 percent decrease from 1947. Tabulation was based on reports of 243 oil companies employing 470,832 persons.

J. R. Carringer Retires After 45 Years With Esso

J. R. Carringer, vice president and assistant to the president of Esso Standard Oil Company, retired on May 1 after 45 years with the company. Entering the oil industry at 17 as an apprentice in a tank car repair shop, in 1914 he was associated with the experimental pressure distillation which led to the Burton-Clark pressure still.

Carringer

In 1918 Carringer was made assistant superintendent of the Bayway Refinery at Linden, N. J. and became manager in 1926. He was appointed assistant general manager of New Jersey refineries in 1933 and assumed a similar position for all company refineries in 1936. Elected a director and general manager of manufacturing in 1940, he was named a vice president in 1943. He became assistant to the president earlier this year.

Robert Friedman Suggested For Oil, Gas Division Post

The National Petroleum Council has suggested Robert Friedman for director of the oil and gas division of the Department of the Interior. Now acting director, Friedman said he was "pleased, but has wanted to leave government service." He has promised to announce his decision shortly.

All committees except standing committees and the committee on oil industry manpower were discharged by the Council at its recent meeting as having served their purposes.

Need for Speedy Synthetic Fuel Program Diminishing

Increased supplies of natural crude has "diminished" the necessity of a speedy development of the commercial synthetic liquid fuels program, E. V. Murphree, president of Standard Oil Development Company, wrote in a recent letter to Senator Martin, Republican, Pennsylvania. At the same time Murphree asserted that if "cost of crude oil production continues to rise, synthetic oil capacity on a large scale will in time become competitive with liquid fuels produced from petroleum."

Standard Oil Development and Pittsburgh Consolidation Coal Company are developing a coal-to-oil pilot plant at Library, Pa. As a result of experiments, Murphree said, "from an economic standpoint we do not believe that the synthetic process in its present state of development is competitive with the manufacture of products from petroleum. We do feel however, that more substantial improvements than those we now foresee are needed to make the production of oil products from coal, competitive under present price structures."

LPG Requirement Would Mean Many Plant Changes

Texas refiners may be required to take liquefied petroleum hydrocarbons as a part of their feed requirements in lieu of crude oil, Brigadier General Ernest O. Thompson of the Texas Railroad Commission told the Refining Division of the API in Houston in April. He suggested that a refinery now running at 10,000 barrels per day crude throughput may be allocated only 9000 barrels of crude plus 1000 barrels of LPG for daily plant feed. He claimed that recent court decisions in the allocation of allowables have indicated that the Railroad Commission has authority for such action.

Some pointed out that such a ruling would call for extensive additions in most refineries. Additional feed of LPG in typical refineries will not be altered appreciably by existing processing schemes, but will end up as just so much LPG product that the refiner must somehow market, it was claimed. If marketing of LPG is not practical, then "the refiner will have little choice other than the installation of gas conversion process units" to convert the excess LPG into gasoline or other salable products.

Corrosion Course Studied

Nathan Schofer, Cities Service Refining Corporation, The Tutwiler Refinery, Lake Charles, La., is chairman of a committee named by the South Central Region of the National Association of Corrosion Engineers to get a consensus on a proposed short course in corrosion engineering. If sufficient interest is evidenced, arrangements will be made with a university engineering school.

McCarthy Names McCord

Donald N. McCord has been engaged in an executive capacity by the Glenn H. McCarthy Interests, his duties to include supervision of plant and construction operations.

For the last three years McCord has been superintendent and project manager for Stone and Webster Engineering Corporation in charge of the construction of the Shamrock Hotel, Houston.

Prior to his connection with Stone and Webster, he was president of his own construction company, McCord and Tiffany, Inc., at Long Island, N. Y. He was also formerly in the construction business in New York City.

API Activities Studied

The executive committee of the American Petroleum Institute has appointed a committee to re-examine and re-evaluate the API and all its activities, the first such study since 1941. A. Jacobsen, Amerada Petroleum Corporation, is chairman. Other members are John R. Suman, Standard Oil Company (New Jersey); R. G. Follis, Standard Oil Company of California; T. E. Swigart, Shell Pipe Line Corporation; and Bruce K. Brown, Standard Oil Company (Indiana).

Dow Chemical Company Shifts Executive Staff

Doan

Bennett

Shifts in the executive staff of The Dow Chemical Company as a result of the death of Dr. Williard H. Dow has placed Earl W. Bennett as chairman of the board, Leland I. Doan as president and Dr. Mark E. Putnam as general manager. In the same action Dr. A. P. Beutel, general manager of Dow's Texas division; and Russell L. Curtis, general manager of the Great Western division, were named vice presidents. Carl A. Gerstacker was elected treasurer and Calvin A. Campbell was elected secretary.

Putnam

Bennett will retain his vice presidential post to which he was named in 1931 and his chairmanship of the company's finance committee. He joined Dow in 1900. Formerly director of sales, Doan came to Dow in 1918. A vice president since 1942, Dr. Putnam is also president of Cliffs Dow Chemical Company. Dr. Beutel came to Dow in 1914 and has been president of Dowell Incorporated since 1939. Curtis joined the company in 1922 and is assistant treasurer and a director. The firm's legal counsel, Campbell entered Dow employment in 1935.

Scientific Conference Lists Papers, Speakers

The United Nations Scientific Conference on Conservation and Utilization of Resources will open August 17 at Lake Success, N. Y., for two weeks. Papers to be presented include:

"Synthetic Fuel Production," Dr. W. C. Schroeder, chief of Office of Synthetic Fuels; "Synthetic Fuel Production," Percival Keith, Hydrocarbon Research, Inc.; "Review of Present Status and Future Trends in Oil Chemistry," Dr. Gustav Egloff, Universal Oil Products Company; "Underground Gasification of Coal," James L. Elder, U. S. Bureau of Mines, and Dr. Milton H. Files, Alabama Power Company; and "Oil from Shale," R. A. Cattell, U. S. Bureau of Mines.

Industry Makes Transition To Long-Term Upward Trend

Transition from a rapid rate of increase back to a small long-term upward trend annually seems to be taking place in the oil industry, Dr. Richard J. Gonzalez, economist for Humble Oil & Re-

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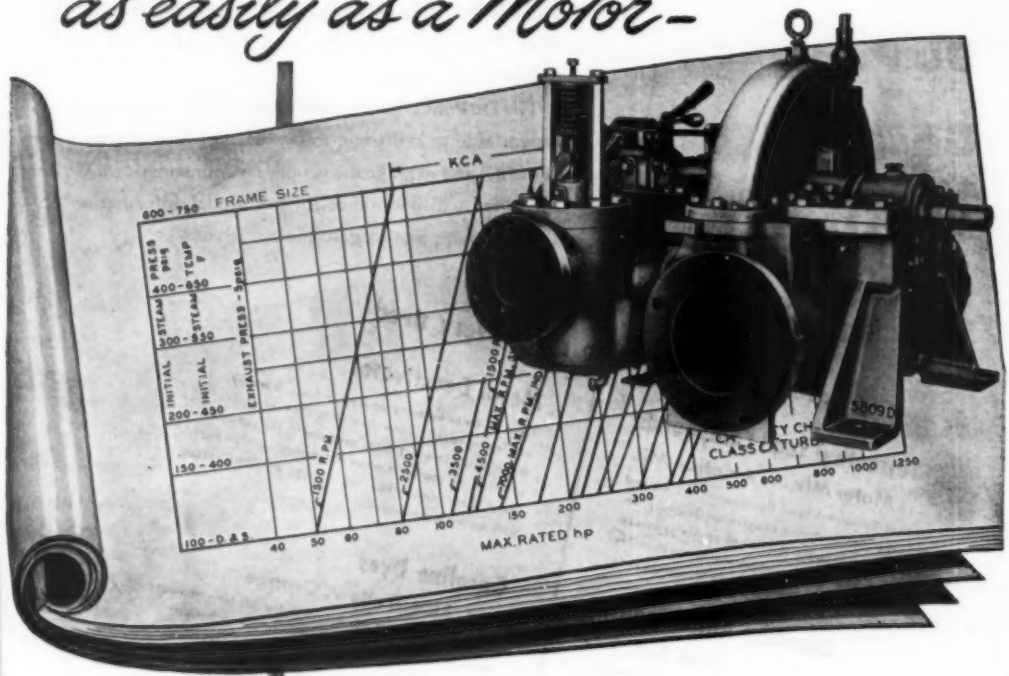

SIMPLIFIED RATINGS FACILITATE SELECTION OF NEW DE LAVAL MECHANICAL DRIVE TURBINES

Because of the great demand for the reliability, speed variability and economy inherent in mechanical drive steam turbines, the De Laval Steam Turbine Co. has designed a new standardized line of velocity stage turbines, manufactured these units in quantity for prompt delivery, and published simplified rating tables that make the preliminary selection of the right turbine size as easy as the selection of an electric motor.

Send for catalog describing the new and improved De Laval Class CA velocity stage steam turbine for mechanical drives.

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T-13

THE MONTH . . .

fining Company, said in a paper presented before the National Petroleum Association Convention in April.

Gasoline consumption probably will gain five percent in 1949, middle distillate will advance 8-12 percent, residual fuel and miscellaneous products will show an increase, but exports will suffer a slight decline, he predicted in the paper. "Refinery yields will have to be adjusted to meet different trends in product demands, but good working stocks can be maintained with only a small net change in inventories," he said. Domestic crude production to meet anticipated demand is estimated to range around 5½ million barrels daily. The present level is 5 million barrels daily.

Stanolind Makes Changes

Personnel changes in its Tulsa office announced by Stanolind Oil and Gas Company include:

Evert W. Kilgren, made a project engineer; Arthur H. Denny, made an operating engineer and John M. Hillsman, made a chemical engineering group leader, all three in the manufacturing department.

Lloyd L. Christensen and Jack P. Barrett, both made technical group leaders at the research laboratories.

New Anglo-Iranian Head

W. D. Heath-Eves is to head the American office of Anglo-Iranian Oil Company, replacing B. R. Jackson who is returning to England to assume duties as a member of the board of directors of the company. The American office, for awhile, at least, will continue to bear Jackson's name.

Organic Sulfur Compound Samples Available from NBS

The National Bureau of Standards has made available to interested laboratories high-purity standard samples of organic sulfur compounds. These compounds, prepared under American Petroleum Institute sponsorship by the Bureau of Mines, are used for the measurement of needed physical, thermodynamic and spectral properties. A portion of each compound is set aside to provide standard samples for calibration of analytical instruments and apparatus in research, development and analytical laboratories.

As of February 1, 1949, three compounds have been issued, each priced at $35 per unit:

NBS Sample Number[a]	COMPOUND[b] Formula	Name	Amount of Impurity[c] Mole Percent	Volume per Unit[d] ml Liquid
901-58	C_4H_4S	Thiophene	0.013 ± 0.011	5
902-58	C_3H_8S	2-Thiabutane (Methylethyl sulfide)	0.04 ± 0.04	5
903-58	$C_4H_{10}S$	3-Thiapentane (Diethyl sulfide)	0.06 ± 0.04	5

[a] The designation "-58" following the sample number indicates a sample of 5 ml sealed "in vacuum" in a special Pyrex glass ampoule with internal "break-off" tip.
[b] See Chem. Eng. News 24, 2765 (1946) regarding the nomenclature of these compounds.
[c] The purity has been evaluated from measurements of freezing points, as described in J. Research Natl. Bur. Standards 35, 355 (1945) RP 1676, unless otherwise indicated.
[d] Tolerance approximately ± 10 percent.

Instructions for ordering may be obtained from the National Bureau of Standards, Washington, 25, D. C. Directions for transferring the samples "in vacuum" are also available from the Bureau.

Sun Appoints Executives For Marcus Hook Refinery

Effective May 1 Louis B. Wells became manager of the Marcus Hook, Pa. refinery of Sun Oil Company, Charles

Maschal

Wells

E. Maschal became assistant manager and W. T. Askew superintendent of the refinery.

Wells started to work for Sun at the Marcus Hook refinery in 1923 after having been with Sun Shipbuilding and Dry Dock Company. He was assigned to the experimental laboratory and worked with the mercury vapor process. Serving as yield clerk and foreman, Wells was named assistant superintendent in 1933 and refinery superintendent in 1944.

Askew

Joining Sun as a still fireman at Marcus Hook in 1933, Maschal served as a technical engineer from 1934 to 1939 when he was named operating assistant. He became assistant superintendent in 1944 and administrative assistant superintendent in 1947.

Askew came to Sun as a chemical engineer in the development division at Marcos Hook in 1931. He was made foreman of the alkylation and gas plants in 1943 and an assistant superintendent in 1944.

Co-ops Suggest Integration For Concentration Problem

Use of the integration process by co-operative oil associations rather than divorcement legislation is the answer to the economic concentration problem in the oil industry, Howard A. Cowden, president of Consumers Cooperative Association, told members of the Economic Action Conference in April. Enactment of the Gillette divorcement bills "would only have the effect of freezing the industry's status quo, preventing the continuation of co-operative growth and leading to higher retail prices for oil products," he predicted.

The solution lies in the "common man joining with his neighbors and channeling his purchases of petroleum products through his own integrated cooperative organization," Cowden said. He suggested tidelands oil, synthetic fuels or Middle East oil as an answer to the "troublesome question" facing co-ops of obtaining crude.

Gets New Celanese Post

Anthony A. Williams has been named assistant director of the product development department of the chemical division of Celanese Corporation of America. He has directed market research in the chemical division since September, 1946, and will continue as head of market research and analysis.

Gets Sloan Fellowship

Robert H. Ausfahl of Standard Oil Company of California has received one of the ten Sloan Fellowships to study for a year at the Massachusetts Institute of Technology.

Ausfahl, a senior analyst in Standard's Department on Organization, will study management, economic and social problems of industrial administration. He was chosen in a nationwide competition.

Don Aikin Named Foreman

Don P. Aikin has been named plant foreman at Stanolind Oil and Gas Company's Superior refinery, Vivian, La. Aikin was formerly doing chemical engineering work at the refinery.

Copenhaver Joins Kellogg

John W. Copenhaver has joined The M. W. Kellogg Company as head of one of its research groups in the Jersey City, N. J. petroleum and chemical research laboratory. He was formerly with General Aniline and Film Corporation at Easton, Penn.

Phillips Names Officers

Paul Endacott has been elected executive vice president of Phillips Petroleum Company. Formerly he was vice president and assistant to the president. At the same time S. S. Learned, chairman of the company's operating committee, was appointed a vice president.

Imperial Oil Elects

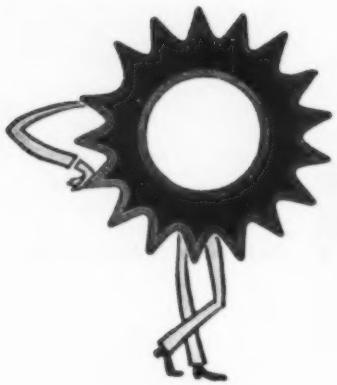
Imperial Oil Company elected G. L. Stewart president and H. H. Hewetson chairman of the board at its annual meeting April 29 in Sarnia, Ontario, Canada.

Canadian Oil Appoints

Canadian Oil Companies, Ltd. has named P. A. Thomson to the newly created position of chairman of the board. W. Harold Rea was named president. He succeeds the late John Irwin.

Republic Offering Three Instrument Short Courses

Republic Flow Meter Company started a four-weeks course on the theory and practical side of flow measurement and automatic control May 2. The first week



WE BITE CHUNKS OUT OF DOWNTIME

TOUGH COKE IS OUR MEAT!

When a bunch of us cutters starts down a tube, mounted on one of those Lagonda swing frame heads, Patton's tanks had nothing on us for covering territory!

It's a fight all the way, sure, but we're set for it—and how! We've got team-work plenty. Take a look at that big 1100 Series Lagonda motor with its ball thrust bearings at each end. There's power for you! Then imagine what happens when those long arms of the Lagonda swing frame head slams us cutters up against the coke! Boy, we go through like a bunch of All Americans through a high school eleven!

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Lagonda straight cutters and cone cutters are of patented "trackless" design, with teeth so spaced that they do not consecutively contact the same spot in the tube. See the spacing of teeth in the star cutter above.

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Lagonda
STILL TUBE CLEANERS

THE MONTH...

of the course was basic instruction on principles and the subsequent three weeks will consist of equipment lectures, demonstrations and shop practice dealing with design, assembly, calibration, adjustment and repair of equipment.

The Company is also planning two separate one-week courses for instrument mechanics. The first of these courses will cover the assembly, calibration and adjustment of instruments. The second course will be similar but will deal with regulators.

These short courses are open to engineers, supervisors and instrument mechanics employed by Republic customers, according to J. B. McMahon, Republic Flow Meter Company, 2240 Diversey Parkway, Chicago 47.

Smith Joins Ethyl Staff

Dr. Charles L. Smith has been appointed to the staff of the product development department of Ethyl Corporation, in New York, to assist in the development and application of various chemical products.

For the past four years, Dr. Smith has been technical advisor of the National Agricultural Chemicals Association, formerly the Agricultural Insecticide and Fungicide Association.

Sample Named Director

John C. Sample will rejoin Standard-Vacuum Oil Company shortly at its New York office as a member of the board of directors. He is now associated with General Petroleum Company as vice president in charge of marketing and a director.

Before joining General in 1937, he was with Standard-Vacuum in Japan for 17 years. He became a director in 1945 and a vice president in 1948.

Trends of Operations and Changes in Stocks

Figures on crude stocks are from Bureau of Mines weekly reports; all others from American Petroleum Institute weekly reports, which are estimates on Bureau of Mines basis.

(All figures in thousands of barrels—add 000)

Trends in Week Ended	Crude Oil			Gasoline		Gasoil and Distillate		Residual Fuel	
	Production Daily	Runs to Stills Daily	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End
1948:									
January 31	5,318	5,434	221,663	15,986	102,973	7,690	40,580	9,141	50,839
February 28	5,387	5,463	220,507	15,796	111,040	7,963	33,836	8,824	49,206
March 27	5,377	5,324	222,814	15,783	112,991	7,682	30,717	8,854	48,334
April 24	5,415	5,517	221,652	16,515	111,128	6,831	34,237	8,877	49,572
May 29	5,452	5,715	221,703	17,827	107,185	7,054	38,641	9,506	55,146
June 26	5,494	5,674	222,081	17,938	104,178	7,200	45,166	8,858	56,812
July 31	5,455	5,718	223,137	17,646	99,116	6,823	56,661	9,080	65,713
August 28	5,529	5,682	222,170	17,722	95,504	7,491	66,321	8,518	70,853
September 25	*5,343	4,789	*226,072	15,100	78,660	5,997	61,884	6,380	37,326
October 30	5,604	5,626	230,633	17,569	91,925	7,679	81,593	8,853	81,299
November 27	5,617	5,721	234,585	17,317	39,802	7,476	85,151	9,477	86,192
December 25	5,641	5,784	240,648	18,178	100,286	7,776	79,271	9,121	86,181
1949:									
January 29	5,493	5,490	246,054	17,531	114,677	7,847	67,432	8,178	84,463
February 26	5,401	5,412	261,965	17,631	124,382	7,430	57,746	8,225	80,246
March 26	5,188	5,353	266,506	17,417	128,087	6,187	48,721	8,305	58,792
April 23	4,973	5,188	†269,544	17,595	125,749	6,087	‡49,643	8,246	‡90,307

* Total U.S. All other September 25 figures do not include California, due to strike.
† April 16 stocks. Beginning with February, crude stocks include California heavy.
‡ Fuel oil stocks on new basis, and not comparable with previous totals.

Metal Congress To Meet On Pacific Coast Biennially

The Western Metal Congress and Exposition is scheduled to hold its technical sessions and show hereafter every two years on the Pacific Coast "because of the success of the 1949 meeting held in Los Angeles," William H. Eisenman, secretary of the American Society for Metals, announced. The 1951 meeting may be held in Oakland or San Francisco and in four years it probably will return to Los Angeles.

Plants in 11 western states were represented at the meeting, with attendance approximately 25,000. Seventeen technical societies cooperated in presenting the congress and exposition.

A. & I. Gas Course Plans

Engineers from Texas, Louisiana, Indiana, New York, Oklahoma, California, and Illinois will be instructors at the Fourth Annual Short Course in Gas Technology at Texas A. & I. College, Kingsville, May 30—June 1. Sponsored by the Southern Gas Association, the course will include field trips to gas installation in the vicinity, including those of the Celanese plant and of the Chicago Corporation.

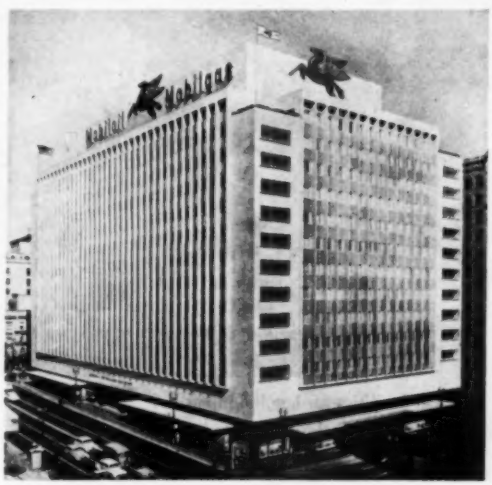
George Parkhurst Elected Standard Vice President

George L. Parkhurst has been elected a vice president of Standard Oil Company of California. He is president of Oronite Chemical Company, Standard chemical products marketing subsidiary.

Parkhurst

Parkhurst joined Oronite in 1946 following service with the Petroleum Administration for War. Prior to the war, he was in the petroleum chemistry industry in the Middle West. He was graduated in chemical engineering from the Illinois Institute of Technology in 1927 and did graduate work in chemistry there for three years. He then studied law for four years and received his J.D. degree in 1934 at De Paul University.

General Petroleum in New Building



The new 13-story General Petroleum Building, Los Angeles, the largest office building in Southern California, was dedicated on April 1. Eight floors are occupied by the home office of the General Petroleum Corporation, the remaining five floors by 45 other companies. The building contains 504,000 square feet and cost $11 million. Atop the building is a superstructure fabricated with a steel "skin" enameled to match the facing of the building.

The exterior is of beige terracotta. The vertical "fins" are of ribbed aluminum and act as sun shades for the windows. Parking is provided for employes and tenants in a spiral-design garage located nearby.

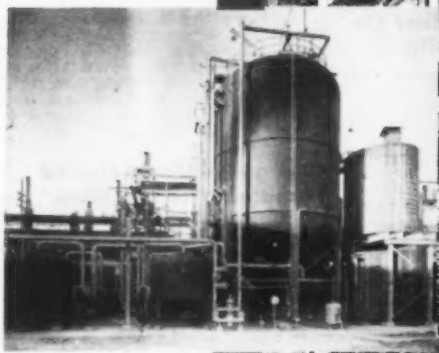
Instrument Exhibit Set

The Fourth National Instrument Exhibit will be held in the St. Louis Municipal Auditorium September 12-16, 1949. Included will be scientific and industrial instruments and devices for measurement, inspection, testing and control.

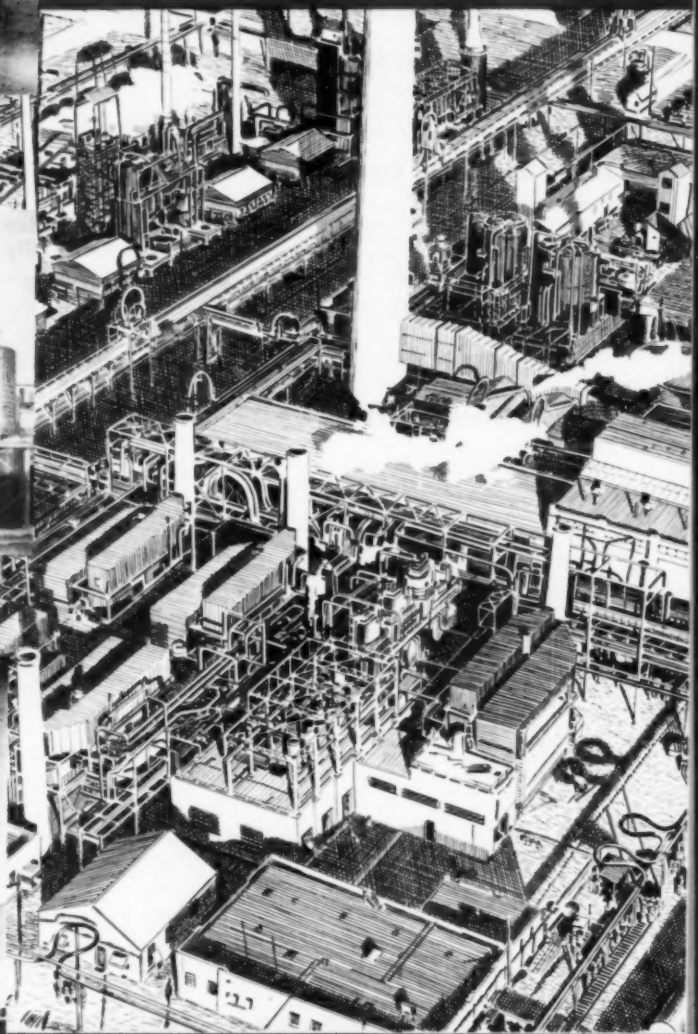
Technical sessions of the Instrument Society of America, American Institute of Physics, Industrial Instruments and Regulators Division of the American Society of Mechanical Engineers and the Instruments and Measurements Committee of the American Institute of Electrical Engineers, the Institute of Radio Engineers, the American Institute of Chemical Engineers and the National Telemetering Forum, will be held in conjunction.

SPECIAL

View inside the power station, showing the three new 10,000-kw turbine generators.



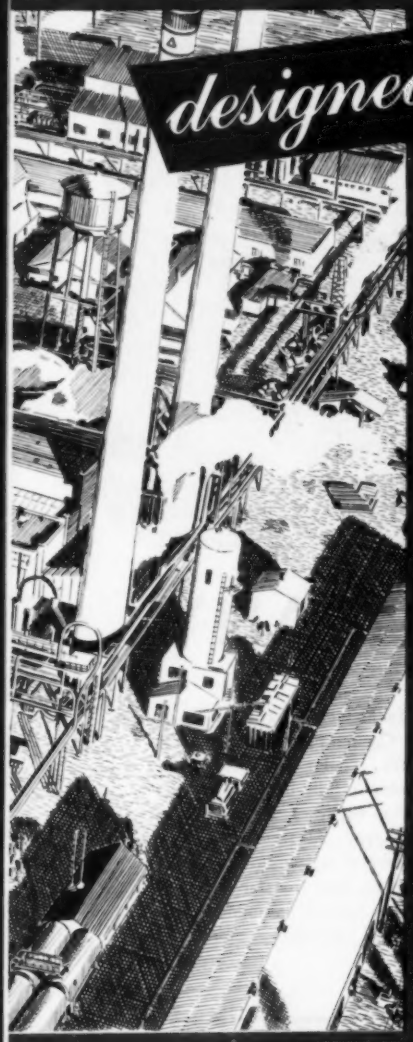
This is the water-treating plant.



Facilities for handling lime for water treatment.

POWER PLANT

designed and built by Fluor



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Use of Exhaust Steam for Process Involves High Backpressure and 90% Water Make-up

A complete power plant of 30,000-kw capacity was designed and built by Fluor for this Texas refinery of a leading oil company.

To supply processes in the refinery with steam at 200 psig, and to provide the required electric power, five 250,000 lb/hr., 650 psig working pressure boilers and three non-condensing, 650 psig input, 200 psig exhaust, 10,000-kw turbine generators were installed. Because of the nature of the operation, only about 10% of the condensate can be economically returned to the boilers. Make-up water constitutes 90% of the water supply. Hence, ample facilities for water treating, deaerating, and lime handling were provided. Details of this interesting and successful power plant are available on request.

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SCIENCE and TECHNOLOGY Abstracts

Prepared by
DR. E. H. LESLIE and DR. H. B. COATS
The Leslie Laboratories
Traver Road, Ann Arbor, Mich.

These abstracts are selected from the current literature of science and technology, not including trade journals easily available. Photostatic copies of original articles will be supplied at cost by The Leslie Laboratories. Complete or limited bibliographies covering special topics by title, by abstracts, or in complete manuscript, also will be prepared and furnished by arrangement with the Laboratories.

Products: Properties, Utilization and Analysis

Deposition and Oil Deterioration Phenomena, Investigation by Means of a Motored Engine. H. DIAMOND, H. C. KENNEDY AND R. G. LARSEN, *Ind. Eng. Chem.* **41** (1949), pp. 495-501.

Many studies have been made in recent years of the deterioration of oils under the conditions prevailing in the crankcase of an engine, but less is known concerning the behavior of the small amount of lubricant that is present at any time in the upper cylinder and is involved in the urgent problems of ring sticking and lacquering. Conditions here are so different, particularly with respect to temperature, that a new approach to the problem is warranted. A test was developed in which an engine is motored while the jacket is heated; ignition, fuel and valve systems are eliminated and the atmosphere inside may be of any desired gas. It was demonstrated that deposits can be formed that arise solely from the lubricant through oxidation. Preoxidation of an oil at moderate temperatures affects its subsequent behavior at higher temperatures. The action of some typical additives in the motored engine is roughly similar to that in a regular engine. Among several possible exhaust and blow-by gas components examined, only sulfur trioxide appreciably promoted deposition. The data are presented in detail in tabular form. Bibliography shows 7 references.

On the Influence of Glass on the Oxidation of Low Viscosity Mineral Oils. D. J. W. KREULEN AND F. G. KREULEN-VAN SELMS, *Jour. Inst. of Petroleum* **34** (1949), pp. 930-40.

The influence of glass on the oxidation of mineral oils of low viscosity was studied. The presence of glass powder strongly affects the oxidation velocity of ordinary oils, but is unimportant in the case of white oils. During the oxidation of white oils peroxides are formed, but in the oxidation of ordinary oils peroxide formation is negligible. Investigations are reported in which the influence of the area of glass surface added and of temperature on the oxidation in the presence of glass is described. Increase in the viscosity of the oil during oxidation is considered and discussed. A method for the determination of the carbonyl value of dark oils is given. In general, the paper deals with low viscosity transformer and lubricating oils. The oxidation of ordinary lubricating oils is still a big study.

Toxic Hydrocarbons. Properties of Hydrocarbons as Related to Their Wood-Preserving Value. J. A. VAUGHAN, *Ind. Eng. Chem.* **41** (1949), pp. 526-30.

As a result of the studies made it appears that new sources of wood-preserving oils can be developed and specifications drawn for all-hydrocarbon wood-preserving oils from whatever sources they may be derived. Research conducted over the last ten years, in an attempt to determine the causes underlying the toxicity of certain hydrocarbons, has led to the development of the controls that can be employed in producing toxic hydrocarbons from any hydrocarbon source material. It has been further determined that the presence of aromatic hydrocarbons and an established specific gravity-boiling point relationship can be used as a means of predicting toxicity toward fungi.

The Inflammability of Oil Mists. J. H. BURGOYNE AND J. F. RICHARDSON, Imperial College of Science and Technology, London, *Fuel*, **28** (1949), pp. 2-6.

A study was made of the inflammability characteristics of suspensions in air of mists derived from oils of low volatility, particularly cutting oils not of the soluble type. The work formed part of an investigation into the hazards of oil mist explosions in machine and heat treating shops. The lower limits of inflammability for condensed oil mists in air have been found to lie in the range 42 to 56 mg. per litre for upward propagation in 1⅞-inch diameter tube. Upper limit for the mist seems to be lower than for the vapor. The minimum additions of diluent to the air for complete suppression of flame are also less for the mists than for vapors.

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1,2-Pentadiene
Hexabromobenzene
cis-9-Decenoic acid
cis-9-Dodecenoic acid
cis-9-Tetradecenoic acid
2,4,5-Trinitrotoluene
Pyrographitic oxide
Phthionic acid
3-Methyladipic acid
1-Nitro-2-naphthol
8-Nitro-1-naphthoic acid
2-Nitrosobenzoic acid
1-Hydroxy-2-anthramine

A Relative Viscosity-Temperature Number. R. T. SANDERSON, *Ind. Eng. Chem.* **41** (1949), pp. 375-8.

A relative viscosity-temperature number (RVTN) is proposed as a possible replacement for viscosity index. Kinematic viscosity-temperature curves of the majority of lubricating oils vary only in shape and in position with respect to temperature. The shape of the curve can be designated by a single number (VTN). The purpose of the present paper is to present a method of viscosity-temperature evaluation that takes into account both the shape and position of the curve with respect to temperature. The relative viscosity-temperature number indicates how the kinematic viscosity vs. temperature curve of a liquid compares with the curve of a hypothetical standard pure compound having the same viscosity at 210° F. This standard compound is chosen so that the dependence of viscosity on temperature is the least assumed to be possible for a pure compound. The question of the relation between viscosity-index and viscosity-temperature-number is briefly discussed. A nomographic chart is given for the determination of RVTN from kinematic viscosities at 100° F. and 210° F. A bibliography of 17 references is included.

Petroleum. HARRY LEVIN, *Anal. Chem.* **21** (1949), pp. 249-56.

The article is part of an annual review of analytical chemistry and covers the trend of development and progress in analysis for the period from just before our entry into World War II until September, 1948. Of the newer analytical tools considered are microchemistry, refractometry, polarography, chromatography, radiation chemistry including ultraviolet, infrared, and Raman, emis-

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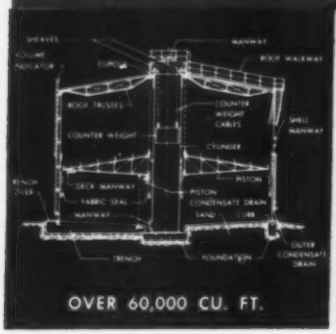

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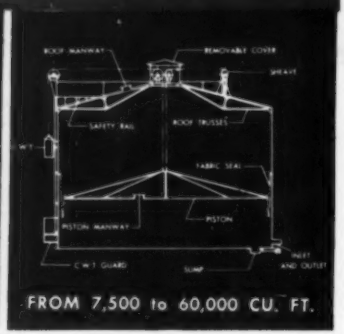

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sion spectrometry, x-ray, mass spectrometry and refinements in high and low temperature distillation. The applications covered are analysis of crude oil, gas, gasoline, kerosene and heavier fuels, lubricating oil, asphalt and specialties. Additional topics are pollution, determination of elements, sulfur and its compounds and catalysts. A bibliography of 245 references is included.

Chemical Composition and Reactions

Pure Hydrocarbons from Petroleum. JOHN GRISWOLD AND J. E. WALKEY, *Ind. Eng. Chem.* **41** (1949), pp. 621-7.

A hexane-henene fraction from a Thermofor catalytic gasoline was separated into paraffinic and olefinic portions by the Distex operation. These two portions were then analyzed by fractional distillation with refractive indexes, aniline points, bromine numbers and specific dispersions taken on small cuts. The percentages of 2,2-dimethylbutane and of n-hexane were small, but the ratios of other isomeric hexanes corresponded approximately to equilibrium at the cracking temperature. Although a complete analysis, expressed as the percentage of each individual hexene was not obtainable, many of the known isomers were present. Data are presented in detail in tabular and in graphical form. Bibliography shows 17 references.

Isomerization of Saturated Hydrocarbons. VI. Effect of Benzene Upon the Isomerization of Methylcyclopentane. HERMAN PINES, EUGENE ARISTOFF AND V. N. IPATIEFF, *Jour. Am. Chem. Soc.*, **71** (1949), pp. 749-50.

Benzene was found to have an inhibiting effect on the isomerization of methylcyclopentane promoted by s-butyl bromide. This is probably caused by the ease with which the benzene reacts with the chain initiator. Inhibition of the isomerization of methylcyclopentane by benzene is in accordance with the proposed chain mechanism of isomerization.

The Thermal Decomposition of n-Hexane. R. G. PARTINGTON AND C. J. DANBY, Oxford University, *J. Chem. Soc.* (1948), pp. 2226-32.

The thermal decomposition of n-hexane was studied with the object of determining the mode of breaking the hydrocarbon chain in the primary process, and whether the residual reaction measurable when the rate has been reduced to a limiting value by added nitric oxide represents a molecular reaction or some kind of chain reaction that persists in spite of the inhibitor. The chance of the hexane molecule breaking in the positions C_{1-2}, C_{2-3} and C_{3-4} are in the ratio, respectively, of 3.9:2.5:1. When the C_{6-3} break occurs the chances are more than 10:1 that ethane and butene-1 will be formed rather than ethylene and butane. Inhibition by nitric oxide of the decomposition of n-hexane indicates that free radicals play a part in the mechanism of the reactions.

Thermal Cracking of Higher Paraffins. H. H. VOGE AND G. M. GOOD, *Jour. Am. Chem. Soc.*, **71** (1949), pp. 593-7.

The composition of paraffins of two to eight carbon atoms has been well

explained as being predominantly a chain reaction involving free radicals. This theory accounts for the products, the inhibition of cracking by nitric oxide and olefins and the initiation of cracking by mercury dimethyl and other materials that readily produce radicals. The cracking of paraffins containing more than eight carbon atoms has not been adequately studied in the light of the theory, yet such materials offer a most stringent test of predicted products of reaction. The thermal cracking of n-hexadecane was observed in a system of flowing reactants at 500° C. and pressures of one and 21 atmospheres absolute. Detailed analyses of the products are given, and those at one atmosphere are shown to be in good agreement with the predictions of the Rice radical chain theory as amplified by Kossiakoff and Rice. Earlier data for the products from an isododecane are also shown to agree with the theory. Rates of cracking for homologous normal paraffins are approximately represented by first order rate constants, which do not fit an equation proposed by Burk, but lead to the empirical relationship $k(sec.^{-1}) = (n-1)(1.57n-3.9) \times 10^{-4}$ for rates at 500° C.

Dehydrogenation of Isopropylbenzene to Alpha-Methylstyrene. J. E. Nickels, G. A. Webb, W. Heintzelman and B. B. Corson, *Ind. Eng. Chem.* **41** (1949), pp. 563-6.

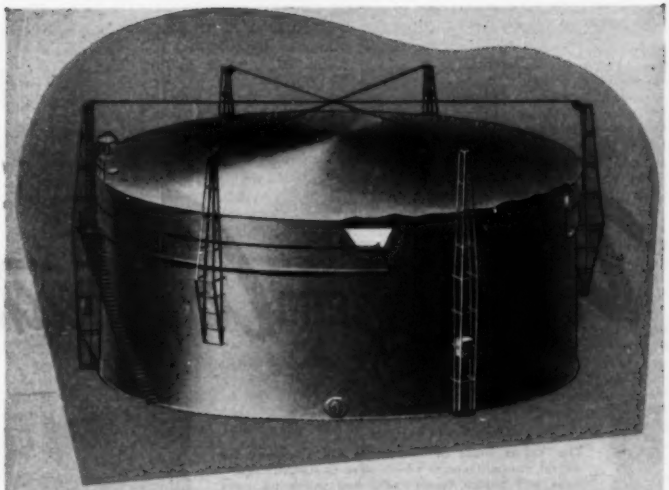
Isoproplybenzene can be catalytically dehydrogenated to alpha-methylstyrene at 600° to 650° C. in the absence and in the presence of diluent steam. Catalytic dehydrogenation is superior to non-catalytic dehydrogenation with respect to selectivity, conversion per pass and ultimate yield. In a 216-hour catalytic run the average alpha-methylstyrene production per pass was 43 percent; the ultimate yields of alpha-methylstyrene and styrene were 71 and 10 percent, respectively, and the hydrogen content of the exit gas was 96 mole percent. Isopropylbenzene is not, however, a preferable stock for the commercial production of styrene, either catalytically or non-catalytically. The yield, however, compares favorably with the 88 percent ultimate yield obtained in the commercial production of styrene by the catalytic dehydrogenation of ethylbenzene.

The Synthesis of Some Cyclopropane Hydrocarbons from Methyl Cyclopropyl Ketone. Ross Van Volkenburgh, K. W. Greenlee, J. M. Derfer and C. E. Boord, *Jour. Am. Chem. Soc.* **71** (1949), pp. 172-5.

The authors describe the synthesis of three cyclopropane hydrocarbons from methyl cyclopropyl ketone. The hydrocarbons prepared were ethylcyclopropane, isopropenylcyclopropane and isopropylcyclopropane. Properties of these hydrocarbons are tabulated. Evidence for the behavior of isopropenylcyclopropane as a pseudoconjugated system is presented.

The Catalytic Hydrogenation of the Benzene Nucleus. V. The Hydrogenation of Benzene, the Cyclohexadienes and Cyclohexene. Hilton A. Smith and Henry T. Meriwether, *Jour. Am. Chem. Soc.*, **71** (1949), pp. 413-5.

The benzene nucleus is hydrogenated with considerably greater difficulty than a simple unsaturated system, presumably because of the large resonance



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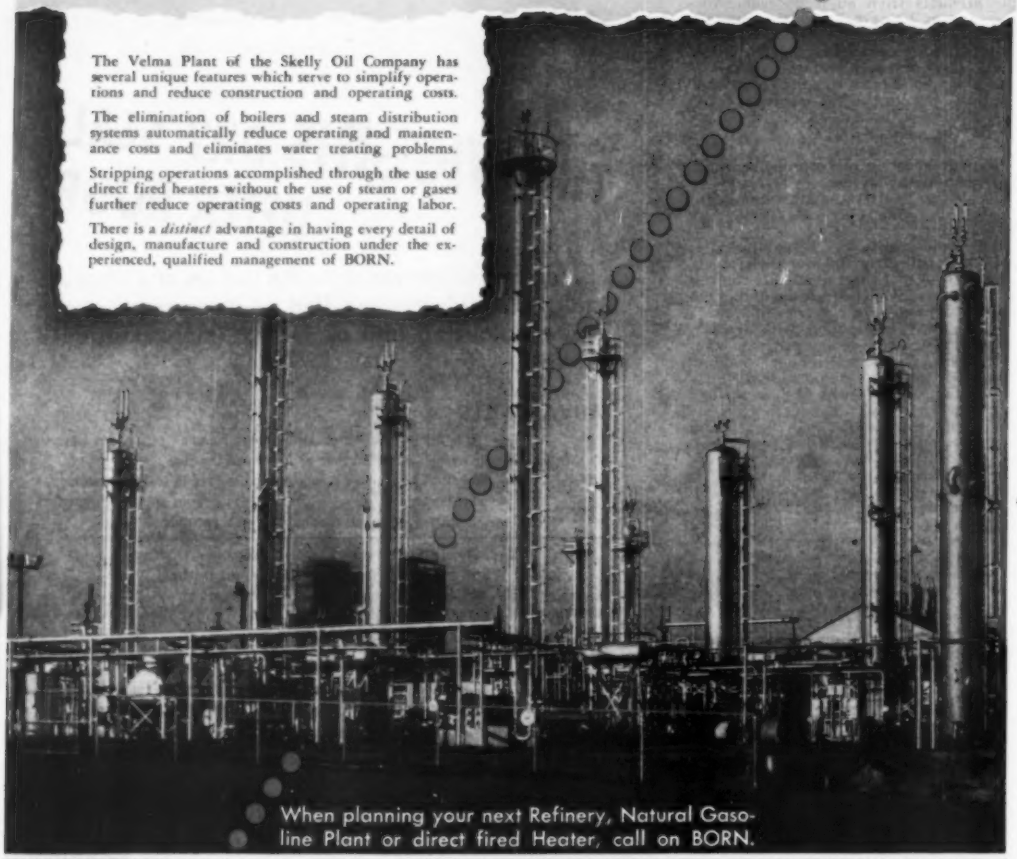

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energy of the benzene ring system. If this is true, one would expect the conjugated 1,3-cyclohexadiene to hydrogenate less readily than either the unconjugated 1,4-cyclohexadiene or cyclohexene. To test this, a study of the rates of hydrogenation of cyclohexene, the cyclohexadienes and benzene was undertaken. A platinum catalyst was used. Rate constants and activation energies were determined for each reaction. The low value of the activation energy of the hydrogenation of benzene when compared with the resonance energy of the molecule indicates the probability that such resonance is destroyed when the benzene is adsorbed on the catalyst.

Sulfonation of 2-Pentene by Chlorosulfonic Acid. SIMON MIRON AND GEORGE HOLMES RICHTER, *Jour. Am. Chem. Soc.*, **71** (1949), pp. 453-5.

Sulfonation of 2-pentane by chlorosulfonic acid in chloroform solution at 0-5° C. gave a reaction mixture of isomeric pentenesulfonic acids. By comparison of the catalytically-reduced mixture with pentane-2 and -3-sulfonic acids, the sulfonation was shown to have occurred to the extent of approximately 80 percent on carbon atom number two and 20 percent on carbon atom number 3.

The Grignard Reagent in Hydrocarbon Synthesis. CECIL E. BOORD, ALBERT L. HENNE, KENNETH W. GREENLEE, WARREN L. PERILSTEIN AND JOHN M. DERFER, *Ind. Eng. Chem.* **41** (1949), pp. 609-16.

The Grignard reaction has been adapted to the preparation of a large number of hydrocarbons on a fair-sized laboratory scale. Several metal reactors were designed for the purpose. Generalized production and purification procedures are described. Specific data, including methods of preparation, yields, physical properties and literature references are given for approximately 80 hydrocarbons. Work has been conducted by the A.P.I. Research Project No. 45. A total of 163 individual hydrocarbons were synthesized and purified. Of this number about half were prepared by methods involving the Grignard reaction. The synthetic procedures used were based on 12 years experience in the synthesis of olefins, dioolefins and phenyl olefins and their hydrogenation to the corresponding saturated derivatives. A bibliography shows 108 references.

Some Substitution Products of the Liquid Isomer of Thiophthen-Thiopheno-2′:3′ (or 4′:3′):2:3-Thiophen. FREDERICK CHALLENGER, PETER H. CLAPHAM AND ROBERT EMMOTT, *Jour. Inst. of Petroleum* **34** (1949), pp. 922-9.

Several new mono-substitution derivatives of the liquid isomer of thiophthen were prepared, including iodothiophthen, methyl thiophthienyl ketone and the corresponding carboxylic acid and its methyl and p-nitrobenzyl esters. Friedel-Crafts and Grignard reactions, and also iodine, have been shown to cause substitution in the same position in the ring. This, as in the case of the solid isomer of thiophthen, is contrary to the behaviour observed with thionaphthen. The orientation of these derivatives is as yet unknown. The liquid isomer prepared from acetylene and boiling sulphur to be identical with thiophthen obtained from citric acid and "Phosphorus trisulphide" by comparison of several analogous derivatives. Bibliography shows ten references.

Composition of Colorado Shale-Oil Naphtha. JOHN S. BALL, G. U. DINNEEN, J. R. SMITH, C. W. BAILEY AND ROBIN VAN METER, *Ind. Eng. Chem.* **41** (1949), pp. 581-7.

Naphthas distilled from crude shale oils produced by several methods of retorting Colorado oil shale were analyzed and found to be remarkably similar in composition. One was selected for detailed study. The approximate composition of raw shale-oil naphtha is: Paraffins and naphthenes 30 percent; olefins 40 percent; aromatics 20 percent; sulfur, nitrogen and oxygen compounds 10 percent. Paraffins and aliphatic olefins, which comprise about two thirds of their respective groups, are predominantly straight-chain compounds. Sulfur, nitrogen and oxygen are present principally in the form of thiophenes, pyridines and phenols, respectively. The results are presented in some detail in tabular and graphical form. Bibliography shows seven references.

Fundamental, Physical and Chemical Data

Phase Equilibria in Hydrocarbon Systems. The n-Butane-Carbon Dioxide System. R. H. OLDS, H. H. REAMER, B. H. SAGE AND W. N. LACEY, *Ind. Eng. Chem.* **41** (1949), pp. 475-82.

The volumetric behavior of five mixtures of n-butane and carbon dioxide was studied at pressures up to 10,000 psi, and at seven temperatures in the interval 100° to 460° F. Results are presented in detail in tabular and graphical form. Compositions of co-existing liquid and gas phases were determined at all temperatures studied which were below the critical temperature of n-butane. Results of the study of the composition of the coexisting phases are compared with data of other investigators as recorded in the literature. Bibliography shows 12 references included.

Phase Equilibria in Hydrocarbon Systems. Volumetric Behavior of Propane. H. H. REAMER, B. H. SAGE AND W. N. LACEY, *Ind. Eng. Chem.* **41** (1949), pp. 482-4.

The work recorded was undertaken to obtain more adequate vapor pressure data for methane and to extend the upper limit of the pressure range. The influence of the pressure and temperature upon the molal volume of propane was determined at nine temperatures between 100 and 460° F. and for pressures from 10,000 psia. to vapor pressure, or above the critical temperature to pressures as low as 650 psi. The volumetric measurements were smoothed with respect to pressure and temperature, and the results are presented in detail in tabular form. They are compared with the results reported by earlier investigators. Bibliography shows 11 references.

Low Temperature Thermal Data on Eight C_nH_{2n} Alkylcyclohexanes. HUGH M. HUFFMAN, SAMUEL S. TODD AND GEORGE D. OLIVER, *Jour. Am. Chem. Soc.*, **71** (1949), pp. 584-92.

The heat capacities of eight C_nH_{2n} alkyl cyclohexanes were investigated over the temperature range 12 to 300° K. Melting points, transition temperatures, heats of fusion and heats of transition for the compounds are given. Entropy values were calculated for the liquid and gaseous state at 298.16° K. The data are presented in detail in tabular form.

Experimental Equilibrium Constants for the Isomeric Hexanes. B. L. EVERING AND E. L. D'OUVILLE, *Jour. Am. Chem. Soc.*, **71** (1949), pp. 440-5.

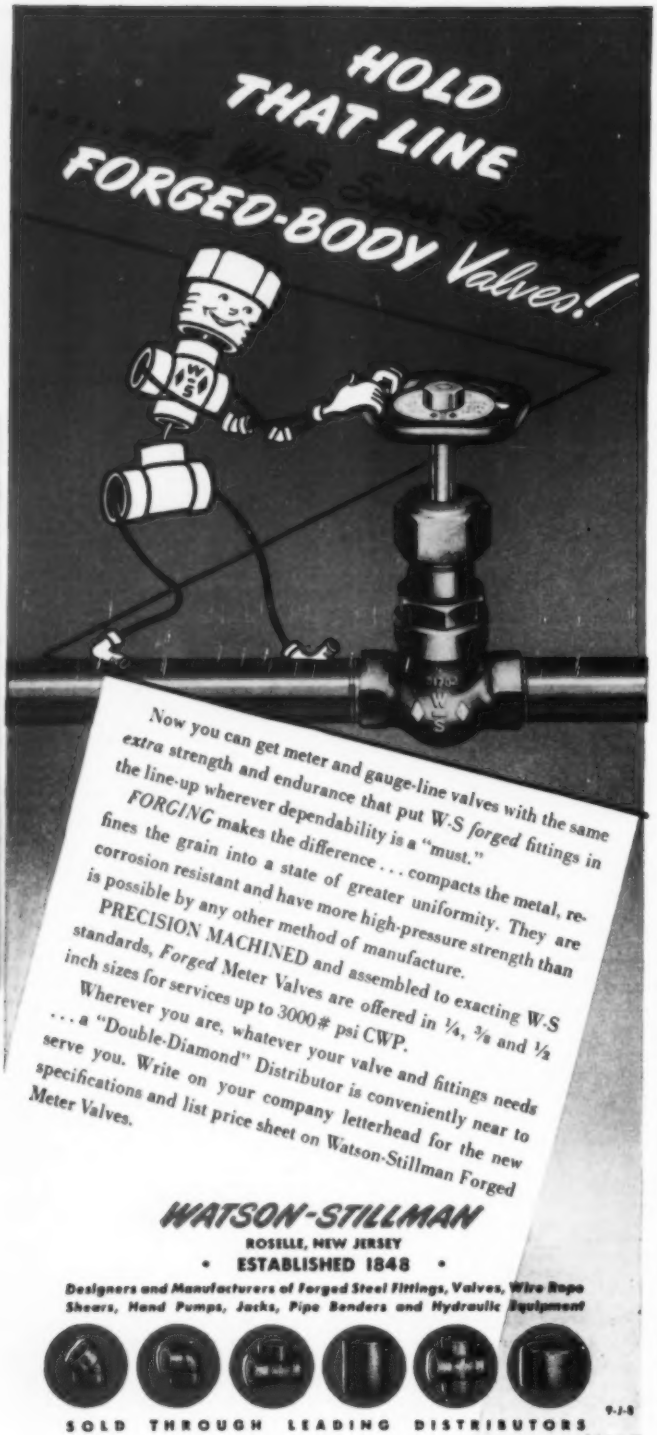
In the course of the development of the naphtha isomerization process, the equilibrium constants for the isomeric hexanes were determined. Studies were made in the temperature range 21 to 204° C. using activated aluminum halide catalysts on a 67° C. end-point light naphtha stock containing both pentanes and hexanes. Results agree with the equilibrium values calculated from the heat of combustion and entropy for n-hexane and 2,3-dimethylbutane. There was a considerable discrepancy for 2,2-dimethylbutane and for the methylpentanes. However, there was substantial agreement in the ratio of 2-methylpentane to 3-methylpentane. The experimental equilibria for the pentanes were also determined and show a higher temperature coefficient than that obtained by some other observers. Hydrogen and extensive side reactions were found to have little effect on the equilibria.

Phenyl- and Cyclohexyleicosanes. J. RUD NIELSEN, LUCILE BRUNER AND KJERSTI SWANSON, *Anal. Chem.* **21** (1949), pp. 369-82.

The infrared absorption spectra of 1-, 2-, 3-, 4-, 5-, 7-, and 9-phenyleicosane and of the correspending cyclohexyleicosanes have been investigated between 1.5 and 15 u. The percent transmittance curves for two cell thicknesses are given, as well as tables of wave lengths, wave numbers and rough intensity estimates of the absorption maxima observed. A number of the absorption bands are associated empirically with vibrations of the phenyl ring, the cyclohexyl group, or the normal paraffin chain. A detailed comparison is made between the spectra of individual members of either series of compounds. The data are presented in great detail in graphical form and a bibliography of six references is included.

Mechanical Properties of Substances of High Molecular Weight. V. Rigidities of Polyisobutylene Solutions in Various Solvents. J. N. ASHWORTH AND JOHN D. FERRY, *Jour. Am. Chem. Soc.*, **71** (1949), pp. 622-8.

Propagation of transverse waves in solutions of polyisobutylene in n-heptane, xylene, isooctane and chlorobenzine was studied as a function of frequency, temperature and concentration. The rigidity G increase only slightly with frequency in the range from 100 to 1000 cycles per second. At constant weight gidity G increases only slightly with increasing temperature; at constant volume concentration, G is independent of temperature. The concentration dependence of G can be interpreted in terms of a transient network structure with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Solubility of Polystyrene in Hydrocarbons. P. O. POWERS, *Ind. Eng. Chem.* **41** (1949), pp. 126-30.

The investigation was a continuation of work on the solubility of low-molecular-weight polystyrene in the normal paraffins. Solubilities of two samples of commercial low-moluecular-weight polystyrene were measured in n-decane and n-octadecane and in mixtures with toluene at temperatures between 20 and 110° C. The resins are soluble in the paraffin hydrocarbons in a limited range, n-decane being the best solvent. Addition of about 30 percent toluene has little effect, but larger amounts of toluene increases the solubility greatly. Above 80 percent toluene in n-octadecane, the more highly polymerized resin is soluble at all concentrations at room temperatures. Solubility plots were made at 20, 50, 80, and 110° C. for the two resins in decane-toluene and in octadecane-toluene mixtures. The results are in general agreement with expectations for polymerized systems except that the critical concentration occurs in several cases at above 50 percent resin concentration. The behavior is believed to be characteristic of resin-plasticizer systems.

Nomographs for Bubble and Dew Points, Benzene-Toluene-Xylene Mixtures. M. H. CHETRICK, *Ind. Eng. Chem.* **41** (1949), pp. 430-1.

Calculation of bubble points, or, as sometimes called, initial boiling points, of multicomponent liquid mixtures usually requires tedious trial-and-error calculations. A rapid nomographic method for calculating bubble points and dew points of mixtures of benzene, toluene and m-xylene is presented. Nomographs for this three-component system have been constructed, and examples are given of their use.

Critical Constants from Parachor and Molar Refraction. H. P. MEISSNER, *Chem. Eng. Progress* **45** (1949), pp. 149-53.

The object of the paper is to consider briefly the problem of predicting the critical constants, and to present several new relations for this purpose. Methods of predicting the critical constants are briefly reviewed and the proposed relationships that apply satisfactorily to water or to substances boiling below 250° K. such as hydrogen, helium, carbon monoxide, nitrogen, oxygen, etc. However, experimentally determined constants are available for these low boiling materials. Equations are given for computing critical volumes, critical temperatures, critical pressures and boiling points.

Thermodynamic Study of Hydrocarbonized Flames. Y. MAYOR, *Energie* **32** (1948), pp. 65-72, 211-16.

The temperature of hydrocarbon flames is developed by a graphical method which takes into account the variation of the specific heat of gases with temperature and also the fact that the combustion products, water and carbon dioxide, are partially dissociated at flame temperature. Curves for different gases used in practice are calculated from the formulas derived and the results given in diagrams. The enthalpy of the combustion products and the ki-

netic and potential energy of the flames can be determined from the diagrams. Calculated flame temperatures for oxygen and for air are given for methane, ethane, propane, ethylene, propylene, butylene, acetylene, carbon monoxide and hydrogen.

Manufacture: Processes and Plant

Heat, Mass Transfer of Gas Film in Flow of Gases Through Commercial Tower Packings. R. G. TAECKER AND O. A. HOUGEN, *Chem. Eng. Progress* **45** (1949), pp. 188-93.

A study was made to establish mass and transfer factors for the gas film in air flowing through Raschig rings, partition rings and Berl saddles. Data were obtained by measuring the rate of evaporation of water into a stream of air from wet packings during the constant-drying-rate period. Packing material was made of a special clay-kieselguhr mixture in order to have high porosity and high capillarity to act as a reservoir for water and to bring the water rapidly to the surface during the constant-rate period. Equations are given for heat transfer with the different packings. For Berl saddles the values of mass transfer factors averaged about 30 percent higher than for Raschig rings. The same results were obtained with both random dense and staggered arrangement of the rings. Additional data will be required to determine the effect of the flowing liquid upon the gas film coefficient for use in scrubber and distillation column design. Detailed data are given in tabular form.

Butene Dehydrogenation. E. W. NICHOLSON, J. E. MOISE, M. A. SEGURA AND C. E. KLEIBER, *Ind. Eng. Chem.* **41** (1949), pp. 646-51.

Large quantities of butadiene were required for the expanding of the synthetic rubber industry soon after Pearl Harbor. Catalytic dehydrogenation of n-butene appeared to be the most promising process. To obtain verification of the practicability of the process and the information necessary to guide the operation of commercial units then being designed, a pilot plant with a capacity of 10 tons per day was built and operated at Baton Rouge, La. The authors describe the process, mechanical features of the pilot plant, failures in its operation, operation procedures, personnel requirements and the results obtained by the process. Flow diagrams are included and some detailed drawings of equipment. Initial information obtained by the operators of the plant is summarized.

Butadiene from Ethyl Alcohol. Improved Production Processes. P. M. KAMPMEYER AND E. E. STAHLY, *Ind. Eng. Chem.* **41** (1949), pp. 550-5.

The American process for making butadiene from ethyl alcohol, as developed by Carbide and Carbon Chemicals Corporation, was operated at a 2.75 to 1 molar ratio of ethyl alcohol to acetaldehyde feed to obtain optimum yields of butadiene. Two improved methods utilizing different over-all feed ratios have been devised; that give higher yields than the conventional plant operations. It has been demonstrated that injecting an auxiliary side stream,

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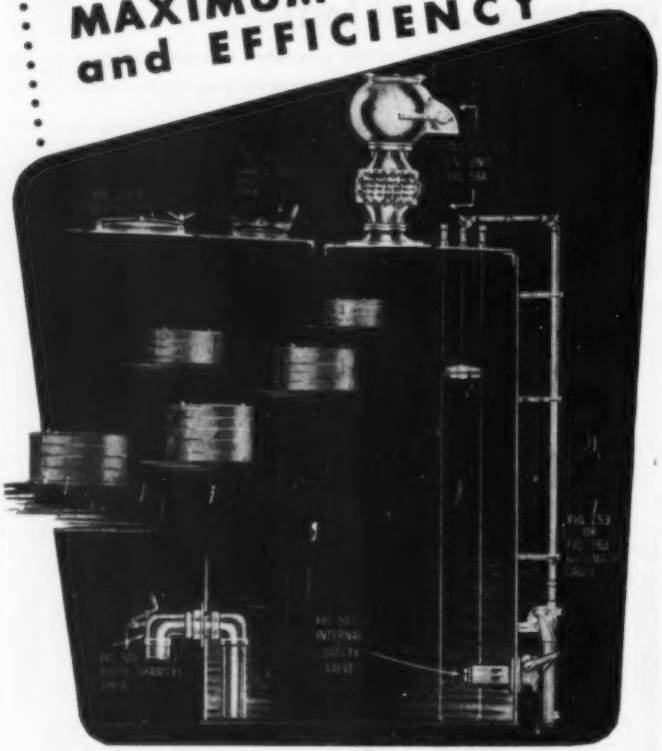

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rich in acetaldehyde, at or above the midsection, where the aldehyde is rapidly depleted, leads to yields of 64 to 68 mole percent and conversions of 35 to 37 mole percent per pass. These compare with 63 and 34 mole percent, respectively, for runs without the side stream. Increased throughput is also realized. The second novel operation procedure comprises an auxiliary feed of ethyl alcohol at or below the midpoint of the catalyst section; this affords consistent yields of about 76 mole percent. Preliminary work on a two-step process with ethyl alcohol-acetaldehyde feeds has been found promising but further study of it must be made. Carbon deposition is not prohibitive in these procedures. Data are presented in some detail in tabular form. Bibliography shows 8 references.

Corrosion in Natural Gas-Condensate Wells. pH and Carbon Dioxide Content of Well Waters at Wellhead Pressure. H. ARTHUR CARLSON, *Ind. Eng. Chem.* **41** (1949), pp. 644-5.

The operation of natural gas-condensate wells has created a difficult corrosion problem. These wells produce water, dissolved salts, carbon dioxide and fatty acids, in addition to hydrocarbons. The corrosion rate of equipment in natural gas-condensate wells has been correlated with the pH and carbon dioxide content of the well waters at wellhead pressures. The pH of three well waters, saturated with carbon dioxide at its partial pressure in the well, was close to that of the waters measured at wellhead pressures, and quite different from that determined in routine water analysis at atmospheric pressure. Rate of corrosion cannot be correlated with the iron content nor with the organic acids content of the well waters. Bibliography shows 10 references.

Wax Crystallization from Propane Solution. N. F. CHAMBERLIN, J. A. DINWIDDIE AND J. L. FRANKLIN, *Ind. Eng. Chem.* **41** (1949), pp. 566-70.

A fundamental study of the problem of propane dewaxing was made through microscopic studies of wax crystals from a mid-continent paraffin distillate. The crystals were observed in their normal environment at various stages of the chilling period by means of a pressure cold stage. When no dewaxing aid was present, the wax crystallized in plates that were arranged in either a flat or a honeycomb structure. When a small amount of asphalt was added as a dewaxing aid, the wax crystallized rapidly immediately below the crystal point into spherical particles of unknown structure arbitrarily called "nuclei". As chilling continued, each nucleus was quickly surrounded by a shell of radiating needles. When a larger amount of asphalt was used a large number of small nuclei formed at a crystallizing point and grew slowly until the filtering temperature was reached. These formations never developed the surrounding shell of radiating needles. Filtering characteristics were critically dependent upon the type of wax structure. Paraflow was also examined as a crystal modifier and was found to produce results similar to those had by the use of asphalt. Only about one fifth as much Paraflow as asphalt was required for a given amount of crystal modification.

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Compiled by HEINZ HEINEMANN

(From the Official Gazette, February 15, 22 and March 1 and 8, 1949)

REFINING

U.S.P. 2,461,917. Aromatic Amines and Fuels Containing the Same. J. W. Orelup.

High octane motor fuels composed of petroleum distillates and primary aromatic amines are stabilized against color deterioration by a small amount of triamyl amine, trihexyl amine or triheptyl amine.

U.S.P. 2,461,972. Motor Fuels. H. G. M. Fischer to Standard Oil Development Company.

A motor fuel consists of an alkylate gasoline base stock, a lead alkyl antiknock agent, 0.1 pound of normal butyl p-amino-phenol and 0.1 pound of hydroquinone per 1000 gallons of fuel. Gum formation and lead precipitation on prolonged storage of the fuel are inhibited by these additives.

U.S.P. 2,461,993. Hydrocarbon Separation by Azeotropic Distillation. A. C. McKinnis to Union Oil Company of California.

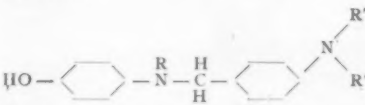
A complex hydrocarbon fraction containing different components of similar boiling ranges is distilled in the presence of an organic azeotrope former with a boiling point not more than 50° F. below the average boiling point of the complex fraction (e.g. methyl ethyl ketone or methyl nitrile). The azeotrope obtained is separately extractively distilled in the presence of a saturated hydrocarbon solvent having a preferential affinity for the hydrocarbon component of the azeotrope and having a boiling point at least 25° F. above the maximum boiling point of this component. The azeotrope former is recovered as overhead. The extractive distillation residue is distilled to vaporize the hydrocarbon component of the azeotrope and to leave the hydrocarbon solvent as bottoms.

U.S.P. 2,462,025. Azeotropic Distillation of Wide-Boiling Range Hydrocarbon Fractions. G. R. Lake and J. M. Stribley to Union Oil Company of California.

A mixed hydrocarbon fraction is distilled in the presence of a primary and a secondary azeotrope former (e.g. acetone and methyl ethyl ketone). Certain of the lower boiling hydrocarbons are vaporized together with the primary azeotrope former. The distillation residue containing the secondary azeotrope former and the remaining lower and all the higher boiling hydrocarbons is separately distilled to vaporize these lower boiling and certain of the higher boiling hydrocarbons with the secondary azeotrope former, while the remaining higher boiling hydrocarbons are recovered from the distillation residue.

U.S.P. 2,462,237. Stabilization of Organic Compounds. R. B. Thompson and J. A. Chenicek to Universal Oil Products Company.

Cracked gasoline motor fuel is mixed with a small amount of a compound of the formula



where R, R', and R" are H or alkyl radicals. N—(4 aminobenzyl)—p-aminophenol is an example of the additive. It inhibits deterioration of the fuel in the presence of oxygen.

U.S.P. 2,462,426. Preparation of Polyalkylbenzyl Phenols. O. M. Reiff and H. D. Hartough to Socony-Vacuum Oil Company, Inc.

Hydrocarbon oil is blended with a small proportion of the reaction product obtained by reacting polyalkylaralkyl halides with a phenol in the molal ratio of 1:2 to 2:1 at elevated temperature in the absence of a solvent. The additive stabilizes the oil against deterioration from oxidation.

U.S.P. 2,463,036. Separation of Cyclic Olefins from Straight Chain Olefins. G. L. Hervert and M. J. Murray to Universal Oil Products Company.

A hydrocarbon mixture containing cycloolefins and open-chain olefins is contacted with an aqueous solution of ethylene glycol monomethyl ether containing 4-12 percent by weight of water under conditions such that two liquid phases are formed which are separated. The raffinate comprises the open-chain olefins and the extract comprises the cycloolefins.

U.S.P. 2,463,076. Treatment of Hydrocarbons. G. B. Zimmerman and C. G. Gerhold to Universal Oil Products Company.

Hydrocarbon liquid containing as impurity a small amount of an organic halogen compound is fractionated in a zone having an increasing temperature gradient from top to bottom. An overhead vaporous product is thereby separated from a liquid bottoms. The hydrocarbons intermediate the top and bottom of the zone are treated with a dehydrohalogenating agent to decompose the organic halogen compound into hydrogen halide and hydrocarbon. The hydrogen halide is removed in the overhead product.

U.S.P. 2,463,077. Process for Treating Hydrocarbon Mixtures to Remove Halogens Therefrom. G. B. Zimmerman and C. G. Gerhold to Universal Oil Products Company.

A process similar to that of U.S.P. 2,463,076 is used for separating dissolved HF and decomposing organically combined fluorine compounds contained in a hydrocarbon mixture.

U.S.P. 2,463,479. Preparation of Aromatic Solvents. W. I. Denton and R. B. Bishop to Socony-Vacuum Oil Company, Inc.

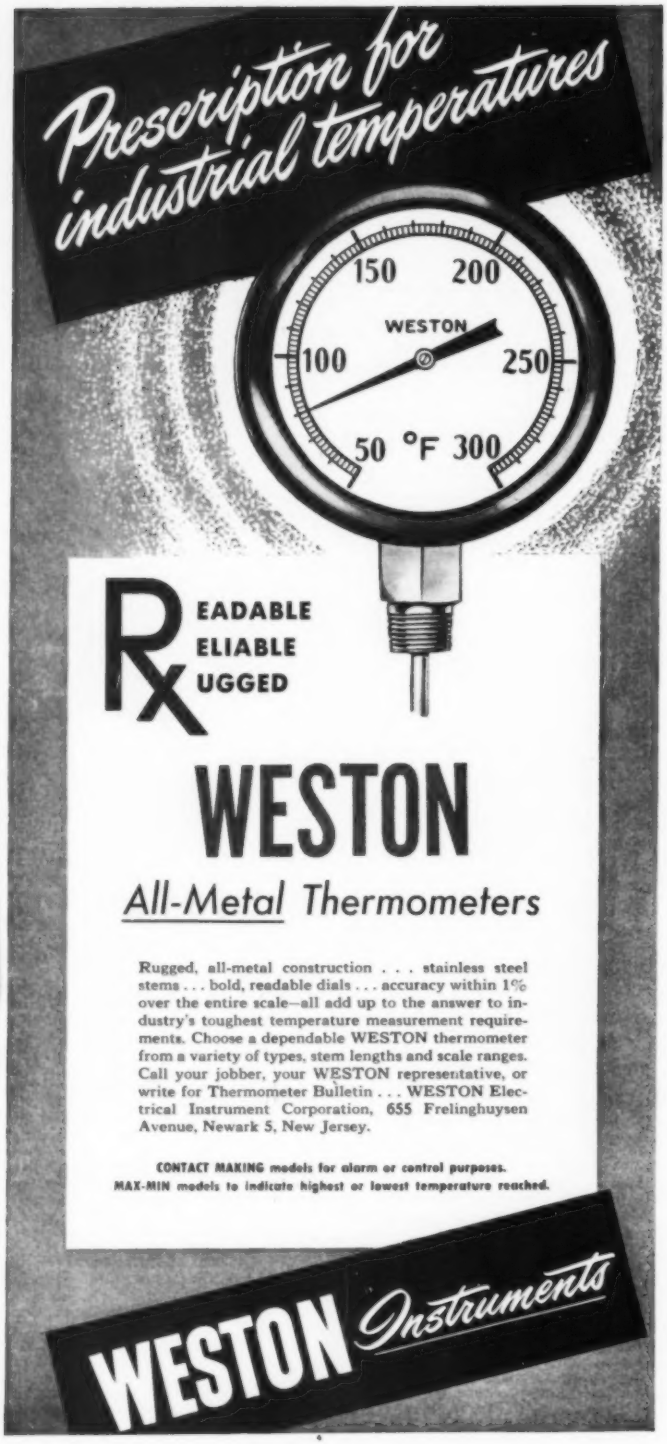
A petroleum stock containing aromatic and non-aromatic components is contacted with a quantity of acetonitrile-hydrocarbon solvent sufficient to selectively extract a major proportion of the aromatics. The resulting extract and raffinate phases are separately distilled. An acetonitrile-hydrocarbon azeotrope is removed as overhead in each of these distillations and is recycled for use as solvent. A bottoms product of high aromatic content is obtained in the extract distillation.

U.S.P. 2,463,482. Separation of Olefins. A. W. Francis to Socony-Vacuum Oil Company, Inc.

Mixtures of olefins with saturated hydrocarbons are contacted counter-currently with a concentrated aqueous solution of a silver salt, such as $AgNO_3$, at high pressure. The olefins are then stripped from this solution by contacting it countercurrently with gaseous or liquid CO_2. Olefins are recovered from the solution with CO_2 by washing with water. N_2O can be employed instead of CO_2 for stripping the olefins from the silver salt solution.

U.S.P. 2,463,601. Separation of Highly Branched Paraffins into Odorless Fractions. C. C. Crawford and L. C. Morris to Phillips Petroleum Company.

An inert, odorless, oxygen-free gas is bubbled through an olefin-free, liquid paraffinic charge stock containing dissolved oxygen and odorous oxygen-containing compounds and resulting from reacting branched-chain paraffin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hydrocarbons with dissolved oxygen to remove the dissolved oxygen. The resulting desoxygenated charge stock is repeatedly fractionally distilled while streams of oxygen-free, inert, odorless gas are passed through the fractionating columns. An odorless distillate comprising liquid branched-chain paraffins is obtained.

U.S.P. 2,463,693. Method and Retort for the Distillation of Solid Hydrocarbonaceous Materials. L. C. Huff to Universal Oil Products Company.

Vaporous and volatile material is recovered from crushed hydrocarbonaceous solids, such as oil shale, tar-sand, coal, by conveying the solids serially through a plurality of distillation zones and passing hot gases in indirect heat exchange relationship with these zones. Distillation products are withdrawn independently from each of the zones. Fines are separated and removed from the solid material of the last distillation zone whereupon the remaining portion of solids is recycled to an intermediate distillation zone.

U.S.P. 2,463,845. Process for Separating Wax from Oil. P. S. Backlund and B. M. Beildeck to Union Oil Company of California.

Details of a process are claimed according to which a wax-oil mixture is first cooled to crystallize a portion of the wax whereupon the remaining cooled fluid wax-oil mixture is mixed at the same temperature with a solvent for the oil, and the resulting oil solution is separated from the undissolved wax.

U.S.P. 2,463,846. Purification of Solvent Used in Diolefin Concentration. F. A. Bain and H. R. Emmerson to Standard Oil Development Company.

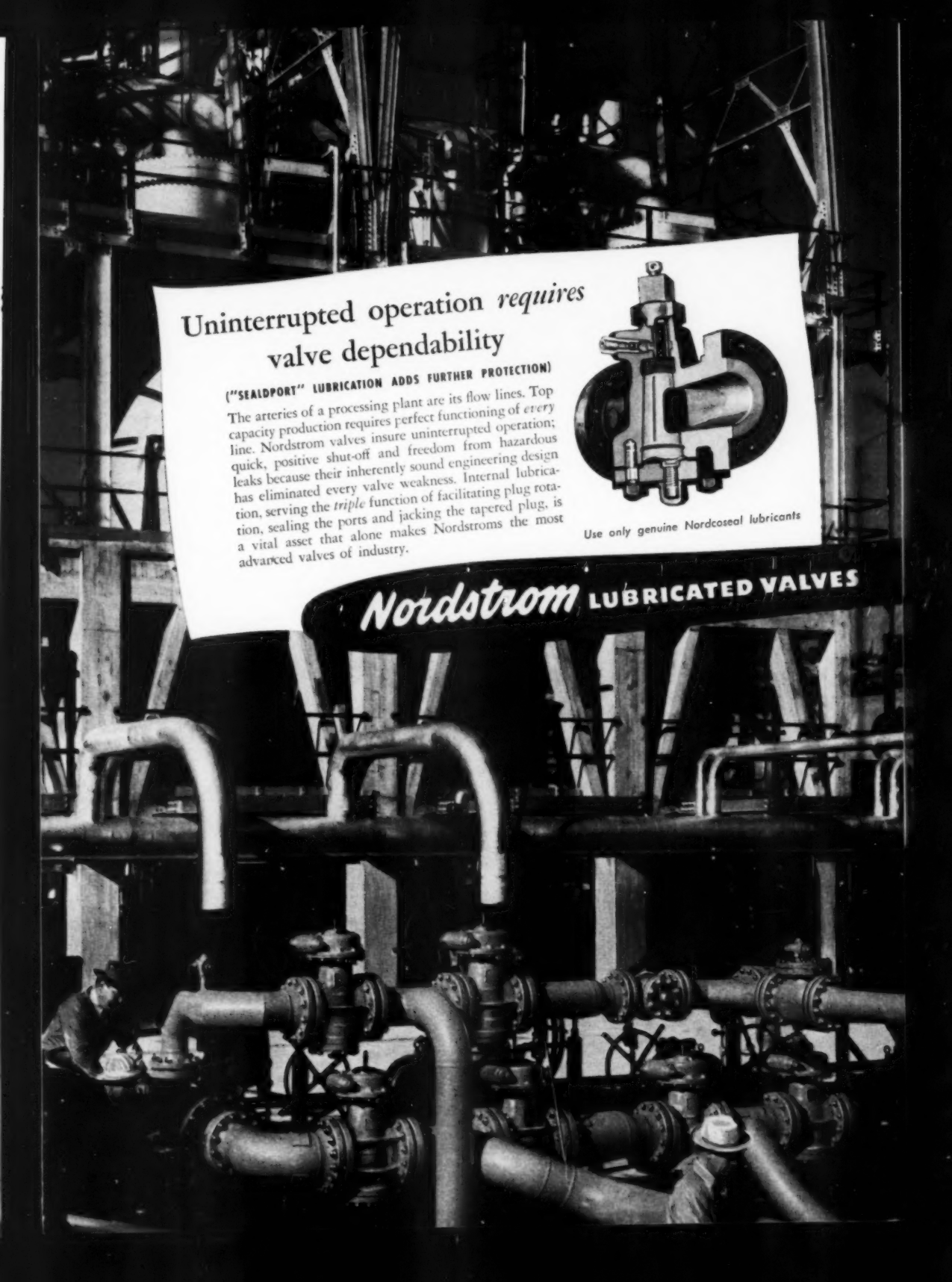
An aqueous cuprous ammonium acetate solvent used for extracting butadiene from a hydrocarbon mixture containing olefins and acetylenes is purified and freed from acetylene polymers and water-soluble foaming contaminants by extracting the spent solvent with a mixture of an alcohol having at least 5 C atoms and with liquid butene to dissolve the contaminants.

U.S.P. 2,463,873. Separation of Pentene-1 from its Mixtures with other C_5 Olefins. R. L. Heinrich to Standard Oil Development Company.

A mixture of C_5 olefins containing at least pentene-1 and 2-methylbutene-1 is contacted with H_2SO_4 of 40-70 percent strength at a temperature of 40-100° F. for 5-60 minutes. After separation of H_2SO_4 from the reaction product which contains 2-methylbutene-2 formed by isomerization of 2-methylbutene-1, the reaction product is distilled to recover pure pentene-1.

U.S.P. 2,463,919. Separation of Close-Boiling Naphthenes by Azeotropic Distillation. J. M. Stribley and G. R. Lake to Union Oil Company of California.

A complex hydrocarbon fraction containing two closely boiling naphthenes is distilled in the presence of an azeotrope former of a boiling point at least 10° C. below that of the higher boiling naphthene and not more than 15° C. below that of the lower boiling naphthene. The azeotrope former can be an ester of an organic or inorganic acid, such as isobutyl nitrite, methyl borate or chloroform. The lower boiling naph-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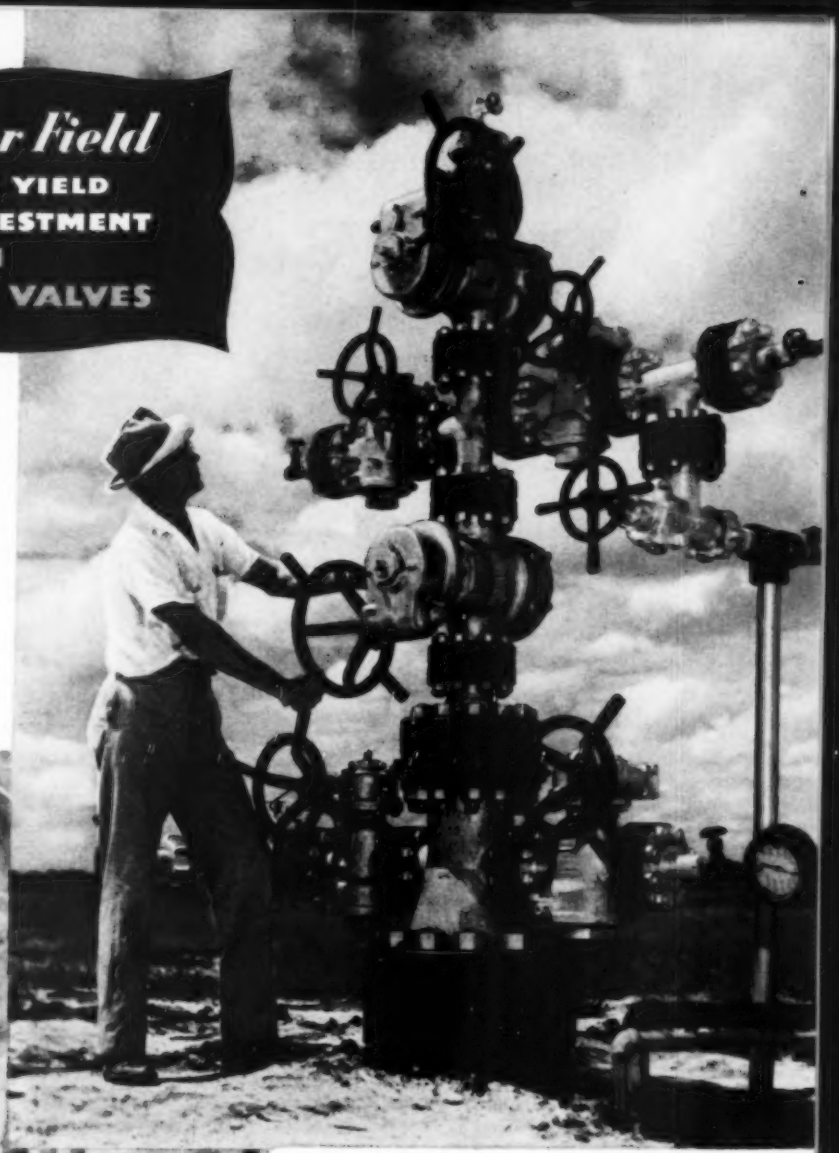

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thene is obtained in the azeotropic distillate. The process is particularly useful in the separation of cyclohexane and methyl-cyclopentane.

U.S.P. 2,463,902. Olefine Extraction Process. M. A. Payne to Standard Oil Development Company.

In the separation of butadiene from an alkaline aqueous cuprous salt absorbing solution also containing absorbed butenes, the solution is heated under a pressure of at least 20 psi, gauge to a temperature of 155-175° F. The pressure is then suddenly reduced as the solution is discharged into a section of a desorption zone intermediate its upper and lower parts. The upper part of the desorption zone is maintained at a temperature of 90-100° F. to desorb butenes from the solution entering this zone. The solution is then further heated to a temperature of 165-175° F. in the lower part of the zone to desorb butadiene.

U.S.P. 2,463,930. Removal of Siliceous Materials from Hydrocarbon Mixtures. J. W. R. Wildman, Jr. to Phillips Petroleum Company.

Small amounts of SiF_4, H_2SiF_6, or a mixture of SiO_2 and HF contained as contaminant in hydrocarbon effluents from a conversion by a fluorine-containing catalyst treated with a silica-containing remover for organic fluorine compounds, are removed by treating the effluent with an aqueous solution of an alkali metal hydroxide of a specified concentration and at a temperature of 100-200° F.

PETROCHEMICALS

U.S.P. 2,461,679. Method of Reacting a Piperylene with a Halo Substituted Maleic Anhydride. A. M. Clifford and C. E. Gleim to Wingfoot Corporation.

Fifty-eight parts of piperylene are reacted with 80 parts of mono- or dichloromaleic anhydride, dissolved in an aromatic hydrocarbon solvent, at a temperature of 0-10° C. A rubbery polymeric material is obtained.

U.S.P. 2,462,103. Preparation of Alpha-Keto-Dihydronaphthalene. R. Johnson to Koppers Company, Inc.

The oxidation product obtained by controlled oxidation of tetralin is decomposed with an aqueous solution of a copper salt of a mineral acid. The alpha tetralol present in the so-formed alpha tetralone is converted to dihydronaphthalene and pure alpha tetralone is recovered by fractional distillation.

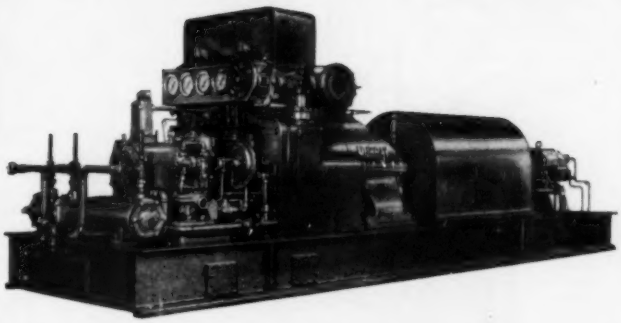
U.S.P. 2,462,163. Manufacture of Esters. F. O. Cockerille to E. I. duPont de Nemours & Company.

Acetylene is reacted with a carboxylic acid in the presence of 0.001-0.01 gram mol of dimethyl aniline per liter of reaction mixture. Vinyl and ethylidene esters are formed. Side reactions are inhibited by the additive.

U.S.P. 2,462,345. Monomeric Fluorine Compounds Containing a Four-Carbon Atom Ring. P. L. Barrick to E. I. duPont de Nemours & Company.

An unsaturated compound having a terminal C-to-C multiple bond, such as isobutylene, is heated in the presence of a polymerization inhibitor at a temperature of 50-300° C. with a monoethylenic

MURRAY
TYPE D TURBO-GENERATOR



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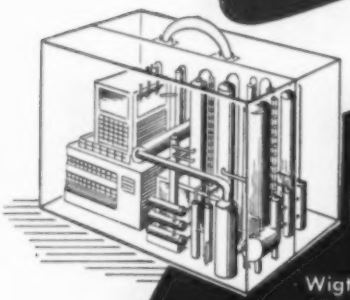

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compound of only two C atoms and containing 2-4 halogen atoms, of which at least two are F, e.g. tetrafluoroethylene. Monomeric organic fluorine compounds containing a four-carbon ring are produced, such as 1,1-dimethyl-2,2,3,3-tetrafluorocyclobutane.

U.S.P. 2,462,346. Aromatic Polyfluoro Four-Carbon Atom Ring Compounds. P. L. Barrick to E. I. duPont de Nemours & Company.

The process described in U.S.P. 2,462,345 is used here for the preparation of aromatic polyfluorocyclobutanes by employing as the hydrocarbon reactant an unsaturated aromatic compound with not more than three-6-C atom rings and a terminal methylene group in a side chain of not more than 4 C atoms, such as styrene.

U.S.P. 2,462,347. Reaction Products of Polyfluoroethylenes and Terminally Unsaturated Compounds. P. L. Barrick to E. I. duPont de Nemours & Company.

Instead of the unsaturated hydrocarbon compounds described in U.S.P. 2,462,345, the compound employed here for the same type of reaction has two terminal C-to-C multiple bonds of which at least one is ethylenic. In using a mixture of butadiene and tetrafluoroethylene monomeric 1-vinyl-2,2,3,3,-tetrafluorocyclobutane is obtained.

U.S.P. 2,462,359. Hydrofluorination of Unsaturated Organic Compounds. J. D. Calfee and F. H. Bratton to Allied Chemical & Dye Corporation.

Unconjugated, unsaturated aliphatic hydrocarbons, such as ethylene or acetylene, are reacted with HF in the presence of fluosulfonic acid to produce corresponding hydrofluorinated compounds, such as ethyl fluoride or 1,1-difluoroethane.

U.S.P. 2,462,448. Method for the Catalytic Production of Oxo-Carbonyl Compounds. G. M. Whitman to E. I. duPont de Nemours & Company.

An olefinic hydrocarbon, e.g. cyclohexene, is reacted under superatmospheric pressure and at a temperature of at least 100° C. with a mixture of CO and H_2 in the presence of a metal from group II of the periodic table having an atomic number of 12-30, such as Ca or Zn. Oxo-carbonyl compounds, such as hexahydrobenzaldehyde, are obtained.

U.S.P. 2,462,555. Copolymers of Styrene and 4,4'-Divinyl-Biphenyl. F. Rosenthal to Radio Corporation of America.

Styrene mixed with 1-5 per cent of 4,4'-divinyl-biphenyl is polymerized while heating in the presence of a catalyst, such as benzoyl peroxide. A resinous copolymer is obtained.

U.S.P. 2,462,593. Pitch Resin. H. R. Batchelder to The United Gas Improvement Company.

A pitch-containing tar emulsion obtained in the vapor phase pyrolysis of petroleum oil in the presence of steam is demulsified and extracted with liquid hydrocarbons to produce a pitch resin. Less than 20 per cent of the resin's weight are soluble in pentane and more than 95 per cent of the resin consists of C and H_2.

U.S.P. 2,462,680. Polymers from Ethylene and Carbon Dioxide. D. E. Sargent to E. I. duPont de Nemours & Company.

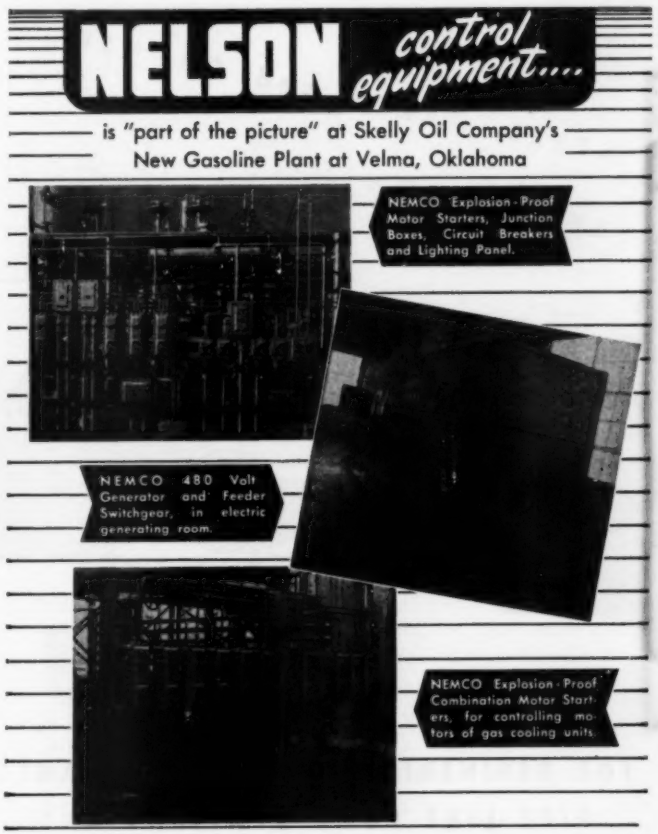
Ethylene and CO_2 are heated in a weight ratio of 0.5:1 to 5:1 at a temperature of 50-300° C. and a pressure above 100 atmosphere in the presence of a free radical-producing catalyst, e.g. an organic peroxide. Carbon dioxide-modified ethylene polymers are produced which are useful in the replacement of natural waxes, for example as components of paste and liquid polishes.

U.S.P. 462,697. Thiophene 2-Carboxylic Acid. V. Weinmayr to E. I. duPont de Nemours & Company.

Thiophene is condensed with acetic anhydride in a nitro-benzene or a chlorinated benzene solvent and in the presence of anhydrous $AlCl_3$. Dissolved aceto-thienone is formed which, after separation from the reaction mass, is oxidized while in the dissolved state with an aqueous alkaline sodium hypochlorite solution. The sodium salt of thiophene-2-carboxylic acid is obtained.

U.S.P. 2,462,703. Copolymers of Multi-olefins with Vinyl Ethers and Method of Making Same. D. W. Young and W. J. Sparks to Standard Oil Development Company.

1-60 per cent of a di- or multi-olefin with 4-10 C atoms, e.g. butadiene or isoprene, is mixed with 99-40 per cent of a vinyl ether with 3-8 C atoms. The mixture is cooled to a temperature of + 10 to —164° C. and then polymerized in the presence of a Friedel-Crafts catalyst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solution which is liquid at the reaction temperature and the solvent of which does not form a complex with the catalyst, such as an akyl chloride solvent. Sulfur-curable rubber-like copolymers can be produced.

U.S.P. 2,462,730. Preparation of Polysulfonyl Chlorides. S. R. Detrick, W. H. Lockwood and N. Whitman to E. I. duPont de Nemours & Company.

Saturated aliphatic liquid hydrocarbon is continuously fed into an elongated reaction zone subdivided into a horizontal series of communicating subzones and irradiated with light of 3000-6000 Angstrom units as it moves along the reaction zone. A gaseous mixture of SO_2 and Cl_2 is simultaneously admitted directly into each of the subzones in the form of a plurality of diffused streams moving in an essentially vertical direction. Any turbulence caused by the motion of the gaseous stream through the liquid stream thus is confined to the particular subzone, and intermingling between the incoming fresh hydrocarbon and outgoing reaction product is avoided. Aliphatic polysulfonyl chlorides are produced continuously.

U.S.P. 2,462,829. Preparation of Oil Soluble Petroleum Sulfonates. P. M. Ruedrich to Griffin Chemical Company.

In the sulfonation of petroleum oil an amount of 5-15 per cent (by weight of the oil) of an oil soluble petroleum sulfonate is added to the oil prior to the addition of conc. H_2SO_4. Oil soluble petroleum sulfonates are obtained in increased yield.

U.S.P. 2,463,456-7. Production of Nitriles. W. I. Denton and R. B. Bishop to Socony-Vacuum Oil Company, Inc.

A methyl, dimethyl or trimethyl cyclohexene, or methyl tetralin is reacted with NH_3 at a temperature of 925-1075° F. in the presence of a molybdenum oxide or a vanadium oxide catalyst. Nitriles with at least 2 C atoms, such as acetonitrile and benzonitrile are obtained.

U.S.P. 2,463,466. Production of Nitriles. M. M. Marisic, W. I. Denton and R. B. Bishop to Socony-Vacuum Oil Company, Inc.

The process of this patent is closely related to that of U.S.P. 2,463,456 and -7. In the present case catalytic oxides are employed which are obtained by treating a heteropoly compound containing a MoO_3, WO_3, or V_2O_5 group at a temperature and for a time sufficient to decompose the heteropoly compound.

U.S.P. 2,463,571. Vinylidene Chloride-Butadiene-Isobutylene Interpolymers. G. W. Stanton and C. E. Lowry to The Dow Chemical Company.

A vulcanizable interpolymer is obtained by copolymerizing an aqueous dispersion of a mixture of 60 per cent vinylidene chloride, 30 per cent butadiene-1,3, and 10 per cent isobutylene.

In U.S.P. 2,463,572-5 similar interpolymers are claimed which are prepared by somewhat changing proportions of vinylidene chloride and butadiene, the isobutylene of U.S.P. 2,463,571 being replaced by replenishing proportions of vinyl acetate, vinyl chloride, alpha-methyl styrene or ethyl acrylate, respectively.

U.S.P. 2,463,742. Ketones. A. C. Byrns to Union Oil Company of California.

An unsaturated hydrocarbon, e.g. a branched chain olefin, is reacted with an organic acid anhydride or a ketene in the liquid phase in the presence of HF or BF_3 to form ketones.

U.S.P. 2,463,850. Process for the Production of Chlorohydrins. B. T. Brooks to Standard Oil Development Company.

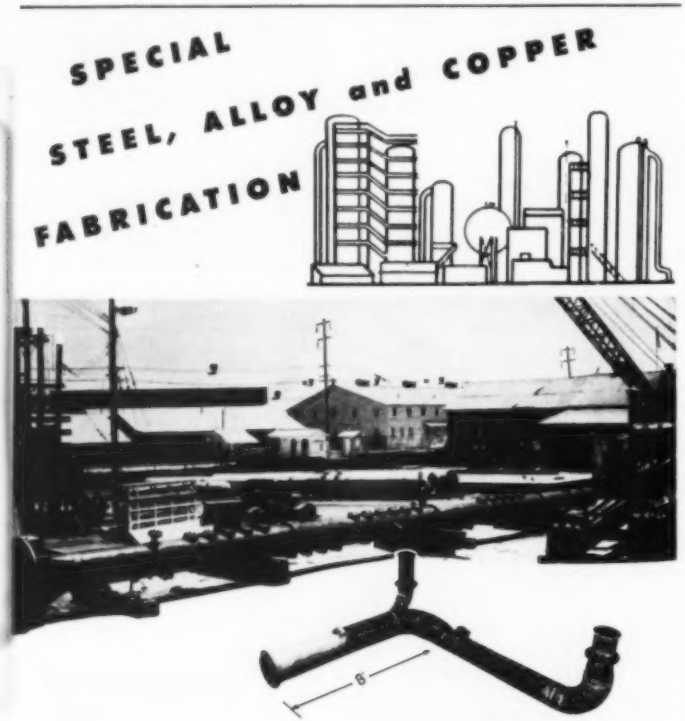
A liquid olefin is mixed with water and CO_2 to form an emulsion. An aqueous alkali hypochlorite solution is slowly added to this emulsion so as to maintain hypochlorous acid of less than 1 per cent concentration in the aqueous phase of the emulsion. The olefin is reacted with this acid as it is formed by the action of the CO_2 on the hypochlorite. An excess of CO_2 is maintained in the emulsion by separate addition of CO_2 during the reaction. A chlorohydrin is recovered.

U.S.P. 2,464,049. Process for Preparing Mercaptans. L. A. Mikeska to Standard Oil Development Company.

An olefin is reacted with H_2S under non-oxidizing conditions in the presence of stannic halide to prepare mercaptans.

DESULFURIZATION

U.S.P. 2,462,391. Treatment of Aromatic Hydrocarbons. H. D. Hartough, A. I.



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Kosak and E. E. Reid to Socony-Vacuum Oil Company, Inc.

Aromatic hydrocarbons containing thiophenic contaminants are reacted with an acyl halide or an anhydride of a carboxylic acid and a porous, adsorptive silica-alumina or silica-zirconia catalyst to effect acylation of the contaminant. The purified hydrocarbon is then recovered by distillation.

U.S.P. 2,462,810. Process for the separation of an Emulsion of Petroleum Oil and Aqueous Solution Containing Added Alkali Metal Salts of Cresols. L. L. Ferguson to Socony-Vacuum Oil Company, Inc.

In the separation of an emulsion of petroleum oil and aqueous solution of alkali metal hydroxide containing added alkali metal salts of cresols used to remove mercaptans, a mixture of oil, aqueous solution and emulsion is flowed upwardly through a vertical confined space of dimensions such as to provide a residence time therein of at least 7 minutes at a liquid velocity of 0.08-0.12 foot per second. The aqueous solution of the treated mixture has a viscosity of 3.5 centistokes. The difficulties otherwise encountered in the separation of desulfurized hydrocarbon oils from the desulfurizing mixture are substantially eliminated by this method.

U.S.P. 2,463,741. Desulfurization and Reforming Process. A. C. Byrns to Union Oil Company of California.

A volatile hydrocarbon feed stock containing organic sulfur compounds and olefins is contacted with 100-10,000 cu. ft. of hydrogen per barrel of oil at a temperature of 650-800° F. and in the presence of a catalyst to convert the sulfur compounds under formation of H_2S and to hydrogenate the olefins. After separation of the H_2S the treated hydrocarbons are mixed with H_2S-free additional hydrogen in an amount of 2000-8000 cu. ft. per barrel and contacted with a catalyst at a temperature above 900° F. to increase the octane number of the desulfurized hydrocarbons.

U.S.P. 2,464,019. Method of Oxidizing Acidic Sulphur Compounds. D. C. Bond and M. Savoy to The Pure Oil Company.

Acidic sulfur compounds, such as mercaptans, occurring in petroleum hydrocarbons are oxidized by contact with free oxygen in the presence of an alkaline polyhydroxy alcohol solution containing a phenolic material capable of forming a quinone upon oxidation.

HEAVY OILS AND WAXES

U.S.P. 2,461,455. Manufacture of Lubricating Oil. F. C. Toettcher to The Texas Company.

A distillate lubricating oil is treated with acetone or furfural. The extract formed is treated with activated clay under conditions similar to those of U. S. P. 2,461,453. The resulting product is blended with the raffinate of the extracting treatment or with distillate lubricating oil to increase their oxidation stability.

U.S.P. 2,461,961. Lubricating Composition. J. P. Buckmann and L. L. Neff to Union Oil Company of California.

The lubricating composition consists

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or mineral lubricating oil and a small amount of an oil-soluble metal salt of an acidic reaction product obtained from a petroleum lubricating oil fraction and an oxide or sulfide of phosphorus at a temperature of 200-600° F. and then reacted with an esterifying agent. The phosphorus content of the additive shall be 0.01-0.5 per cent. The composition is anti-corrosive.

U.S.P. 2,462,360. Method of Preparing Lubricating Oils. P. H. Carnell to Phillips Petroleum Company.

A lubricating oil is prepared from olefin polymer formed as by-product in the hydrofluorination of a low-boiling aliphatic olefin. Details of the process are claimed.

U.S.P. 2,462,616. Lubricating Oil Containing an Oxidant. L. T. Eby and L. A. Mikeska to Standard Oil Development Company.

A petroleum hydrocarbon product, particularly a lubricating oil, contains a small proportion of a compound of the formula $(RA_r)_nH_nBO_3$ where Ar is an aryl nucleus; R represents at least one alkyl radical, these radicals containing a total of at least 16 C atoms; m is an integer 1-3; n is 0-2; and m + n equal 3. A wax alkylated phenyl borate can, for example, be employed as the additive which has oxidation inhibiting properties.

U.S.P. 2,462,970. Frost Removing Composition. J. B. Holtzclaw to Standard Oil Development Company.

The tenacious adhesion of frost to chilled surfaces is prevented by a non-corrosive paste consisting of 60-80 per cent by weight of white mineral oil, 12-18 per cent $CaCl_2$, not more than 1 per cent of an inorganic rust inhibitor, such as $NaNO_2$, and a water-soluble Ca-soap of higher fatty acids constituting the remainder.

U.S.P. 2,463,429. Lubricant. E. N. Roberts to Standard Oil Company (Indiana.)

A hydrocarbon oil is compounded with 0.001-2 per cent of a polyhydroxy aromatic alcohol or aldehyde and 0.001-10 per cent of a neutralized P- and S-containing reaction product of a phosphorus sulfide and an olefin polymer, such as polybutylene. The lubricant is non-corrosive and resistant to oxidative deterioration.

U.S.P. 2,463,822. Greases. J. C. Stamm to Standard Oil Company (Indiana.)

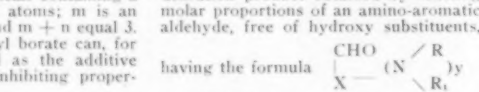
A mixture of 10-90 per cent by weight of a sulfur-bearing hydrocarbon oil and 90-10 per cent of rosin is heated to 450-525° F. for 1-12 hours and is subsequently saponified to produce a rosin soap grease.

U.S.P. 2,463,823. Greases. A. W. Weitkamp to Standard Oil Company (Indiana.)

A mixture of hydrocarbon oil and unpolymerized resin is heated at 350-450° F. in the presence of 0.1-1 per cent by weight of a catalyst consisting of S, Se or Te, but in the absence of a hydrogenation catalyst, to produce upon saponification a grease of desired setting and penetration characteristics. Alkali or alkaline earth metal bases or mixtures thereof can be used for the saponification.

U.S.P. 2,463,836. Oxidation Resistant Organic Substances. R. W. Watson to Standard Oil Company (Indiana.)

A petroleum oil, such as lubricating or turbine oil, is compounded with a condensation product obtained by reacting molar proportions of an amino-aromatic aldehyde, free of hydroxy substituents, having the formula



in which X is benzene or naphthalene, R is hydrogen, benzene, naphthalene or an alkyl radical, R_1 is benzene, naphthalene or an alkyl radical, and y is 1 or 2, with an aliphatic mono-amine or a polyalkyleneamine containing at least 2 primary amino groups. The additive inhibits oxidative deterioration of the oil. The additive can, for example, be obtained by the condensation of N-benzylamino benzaldehyde with ethylenediamine.

U.S.P. 2,463,872. Production of Synthetic Lubricating Oil. R. L. Heinrich to Standard Oil Development Company.

An alpha-olefin, such as pentene-1, is polymerized with the aid of an anhydrous Friedel-Crafts catalyst in the presence of an isoparaffin diluent, e.g. isopentane. A polymer in the lubricating oil boiling range is formed which is mixed with hydrogel halide to terminate the polymerization reaction and to initiate alkylation of the polymer with the isoparaffin present. A substantially saturated lubricating oil is obtained.

HYDROGENATION, DEHYDROGENATION, AROMATIZATION

U.S.P. 2,461,570. Synthesis of Liquids from Carbon Monoxide and Hydrogen. J. K. Roberts to Standard Oil Company (Indiana.)

In the synthesis of liquid products from a CO-H_2 gas in the presence of a synthesis catalyst, a gas mainly consisting of H_2, CO_2, and CH_4 is separated from synthesis conversion products and employed for treating active synthesis catalyst while the synthesis step is proceeding.

U.S.P. 2,461,959. Catalytic Hydrogenation of Triisobutylene. R. C. Brandon to Standard Oil Development Company.

A sulfur-contaminated triisobutylene polymer is reacted with hydrogen at a temperature of 200-600° F. in the presence of a catalyst comprising a hydrous alumina carrier having ultra microscopic pores and 0.1-10 per cent of Pt or Pd. The catalyst can be continuously employed for up to 100 hours or more without substantial loss of activity. High anti-knock aviation fuel is produced in continuous operation.

U.S.P. 2,463,875. Hydrocarbon Synthesis Process. H. J. Hibshman to Standard Oil Development Company.

Oxides of carbon and hydrogen are contacted with a suitable catalyst under suitable temperature and pressure conditions. Reaction gases removed overhead from the reaction zone are scrubbed with a petroleum oil of an A.P.I. gravity of 10-26° at a temperature equivalent to that of the reaction zone. A portion of the scrubbed gases is recycled to the reaction zone while synthetic hydrocarbons are recovered from the scrubbing oil.

U.S.P. 2,463,912. Synthesis of Hydrocarbons. W. G. Scharmann to Standard Oil Development Company.

CO and H_2 are contacted under conversion conditions with a dilute suspension of a finely divided synthesis catalyst in a gas. The amount of catalyst in the suspension is controlled at a concentration sufficiently low to permit conversion and resultant heat release to take place at a uniform rate over an extended path of contact between reactant gases and catalyst. Unreacted CO and H_2 are withdrawn from the reaction zone and contacted with a dense turbulent fluidized mass of finely divided synthesis catalyst at conditions conducive to completion of the conversion. The dilute catalyst suspension can be formed within the conversion zone by admixing finely divided catalyst to the passing reactant gases.

ISOMERIZATION

U.S.P. 2,461,540. Process for the Isomerization of a Low-Boiling Saturated Hydrocarbon. F. E. Frey to Phillips Petroleum Company.

A normal paraffin with 4-6 C atoms is subjected in liquid state to the action of a liquid catalyst consisting of HF and 1/5 per cent (by weight of the HF) of BF_3. Isoparaffins of the same and of a different number of carbon atoms in the range of 4-6 are obtained.

U.S.P. 2,461,541. Process for Isomerizing a Low-Boiling Isomerizable Saturated Hydrocarbon. F. E. Frey to Phillips Petroleum Company.

The process according to this patent is similar to that of U.S.P. 2,461,540. The catalyst here consists of concentrated liquid HF containing 1/10 per cent of BF_3 and 0.05-1.0 per cent of water. Water is continuously added to the reaction zone in an amount sufficient to maintain the indicated concentration of HF.

U.S.P. 2,461,545. Isomerization Process. H. J. Hepp to Phillips Petroleum Company.

The details of a process are claimed for isomerizing n-hexane to diisopropyl and neohexane by means of a catalyst consisting of HF and 1/10 per cent of BF_3 in two steps, the first of which is carried out under severe and the second under mild reaction conditions.

U.S.P. 2,461,568. Paraffin Isomerization Process. J. L. Richmond to Phillips Petroleum Company.

The liquid catalyst comprising HF and 0.1-10 per cent of BF_3 is here employed for the isomerization of a low-boiling normally liquid paraffin with at least 5 C atoms, mixed with 5/25 per cent of a low-boiling cycloparaffin with at least 5 C atoms in the ring, at a temperature of 50-300° F. The ratio of catalyst to hydrocarbons shall be between 0.1:1 and 3:1. The secondary

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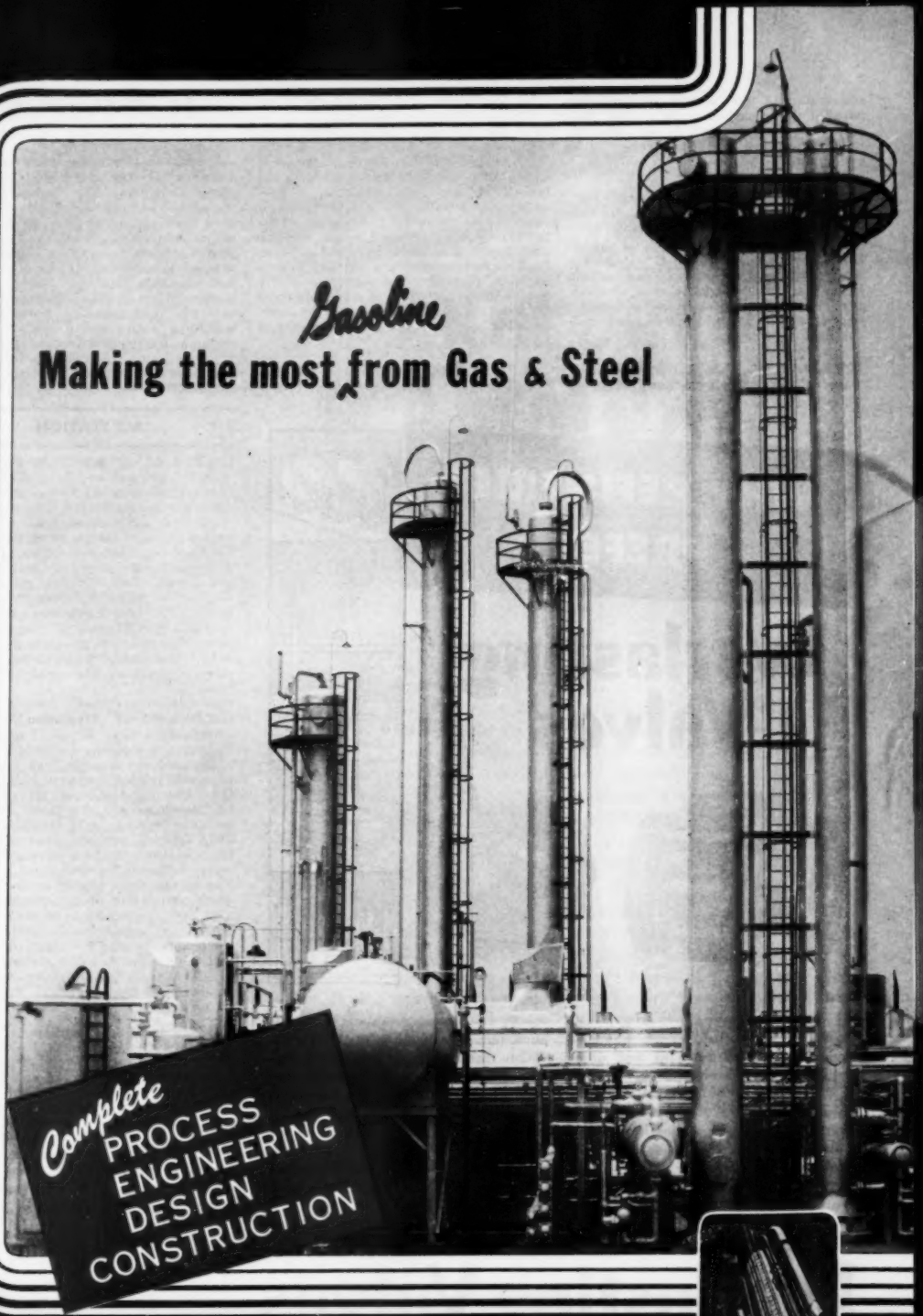

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conversion of the normal paraffins to paraffin hydrocarbons other than the corresponding isoparaffins is substantially suppressed by the presence of the cycloparaffins.

U.S.P. 2,461,598. Process for the Isomerization of Paraffins. J. D. Gibson to Phillips Petroleum Company.

The process according to this patent is closely related to that of U.S.P. 2,461,568. A low-boiling aromatic hydrocarbon in an amount not greater than about 5 per cent of the total hydrocarbons is here employed as the additive instead of the cycloparaffin.

U.S.P. 2,463,187. Dehydration of Hydrogen Chloride-Hydrocarbon Mixtures by Distillation. J. W. Latchum, Jr. to Phillips Petroleum Company.

In the isomerization of n-butane in the presence of $AlCl_3$ and HCl_3, the $AlCl_3$-free effluent from the reaction is fractionally distilled. An overhead containing HCl, propane, lighter hydrocarbons and water is withdrawn, which overhead contains HCl in excess of 67 per cent of the combined weight of HCl and water. The bottoms contain n-butane, isobutane and any heavier hydrocarbons present. A hydrocarbon-HCl layer substantially free of water obtained by at least partially condensing the overhead is recycled to the isomerization zone.

U.S.P. 2,463,610. Treatment of Hydrocarbons with Metallic Halide-Hydrocarbon Complex Catalysts. W. F. Glassmire, W. R. Smith, N. B. Haskell and K. A. Danskin to The Texas Company.

In a process for the isomerization of n-butane in the presence of $AlCl_3$-paraffin hydrocarbon complex liquid containing uncombined $AlCl_3$, this complex liquid is passed after use to a zone of electrolysis to form in its electropositive portion complex liquid of increased uncombined $AlCl_3$ content while lean complex liquid of lowered $AlCl_3$ content is left in the electronegative portion and discharged. A portion of the n-butane feed stream is by-passed through the electro-positive portion to effect solution of uncombined $AlCl_3$. The resulting solution is conducted to the reaction zone.

ALKYLATION

U.S.P. 2,462,792. Alkylation Process. F. D. Wadsworth and R. J. Lee to Pan American Refining Corporation.

In the alkylation of polycyclic aromatic hydrocarbons, such as polymethyl naphthalenes, a stream of olefin, such as butylene, is contacted in an alkylation zone with the aromatic hydrocarbons and an anhydrous toluene sulfonic acid catalyst at elevated temperature (e.g. 265-300° F.) and a pressure sufficient to maintain liquid phase in the alkylation zone. The reaction products are diluted with a saturated hydrocarbon, and a phase comprising the catalyst is separated.

U.S.P. 2,462,793. Alkylation and Catalyst Recovery. R. J. Lee to Pan American Refining Corporation.

The process according to this patent is closely related to that of U.S.P. 2,462,792. The alkylation of all alkylatable hydrocarbons with the aid of anhydrous aromatic sulfonic acid is claimed here. This sulfonic acid is converted during the alkylation of the hydrocarbon to an ester of the olefin employed. The addition of the olefin stream is discontinued upon completion of the desired alkylation and the reaction mixture is then heated to reconvert the sulfonic acid ester and regenerate the free acid, whereupon the mixture is treated with a saturated hydrocarbon to reduce the solubility of this acid and thus to recover it.

U.S.P. 2,463,078. Treatment of Hydrocarbons. G. M. Webb to Universal Oil Products Company.

In the catalytic alkylation of hydrocarbons in the presence of HF, the resulting hydrocarbon fraction containing a small amount of an organic fluorine compound is contacted with metallic aluminum. The thus liberated HF is separated from the hydrocarbon fraction and returned to the alkylation step.

U.S.P. 2,463,262. Alkylation Method and Apparatus. A. R. Goldsby to Texaco Development Corporation.

Low boiling isoparaffins are catalytically alkylated in a long closed agitated reaction zone wherein liquid catalyst and isoparaffin are introduced together adjacent one end of the zone while alkylating agent is introduced into the reaction mix by multipoint addition from a large number of points spaced throughout the greater part of the zone. Additional liquid catalyst premixed with the

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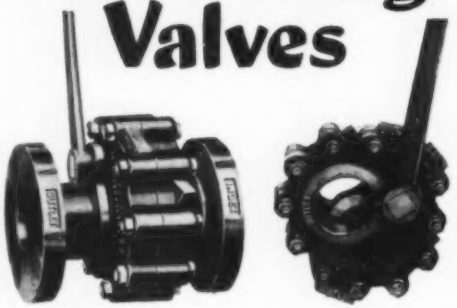

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low boiling isoparaffins is introduced at a large number of points intermediate the first named introduction points.

U.S.P. 2,463,768. Alkylation Process. H. J. Hepp to Phillips Petroleum Company.

In the alkylation of an isoparaffin with a low-boiling olefin in the presence of a recycled aluminum halide-hydrocarbon complex catalyst, this catalyst is maintained at a substantially low viscosity by effecting only partial separation of the catalyst and recovering a catalyst mixture which contains aluminum halide-hydrocarbon complex and alkylatable hydrocarbons in specified proportions.

CRACKING AND REFORMING

U.S.P. 2,461,958. Treating Hydrocarbon Fluids. L. S. Bonnell to Standard Oil Development Company.

Freshly regenerated catalyst particles are contacted in a first zone with vapors of a virgin oil stock. Vaporous reaction products are withdrawn overhead. Fouled catalyst particles from this zone are contacted in a second zone with oil vapors of higher coking tendency. The vaporous reaction products from this zone are further contacted with fresh catalyst particles in the first zone. Spent catalyst from the second zone is regenerated and recycled to the first zone. The process is particularly useful in the cracking of hydrocarbons.

U.S.P. 2,463,903. Manufacture of Gasoline. H. L. Pelzer to Sinclair Refining Company.

A mixture of a high boiling petroleum distillate stock and a small proportion of finely divided argillaceous material (e.g. of a synthetic silica-alumina catalyst) is heated at about 950-1100° F. while flowing as a stream at a velocity sufficient to maintain the solid material in suspension in the stock for a period of time sufficient to convert a substantial part of the stock by cracking into gasoline hydrocarbons. The hot products are separated in a coke separating zone into a composite vapor fraction and a dry coky residue containing the argillaceous material. A high boiling tarry fraction, a lower boiling fraction and a low boiling gasoline fraction are separately condensed from the composite vapor fraction.

POLYMERIZATION AND CONVERSION

U.S.P. 2,461,820. Conversion of Ethylene. S. J. Hetzel and R. M. Kennedy to Sun Oil Company.

A mixture of ethylene and ethane is subjected to elevated temperature in the presence of a catalyst consisting of a major proportion of silica gel and minor proportions of alumina and nickel or cobalt. Higher boiling materials are obtained.

U.S.P. 2,461,932. Process and Apparatus for the Treatment of Hydrocarbon Oil with Catalysts. A. D. Smith to Adsorptive Process Company.

The details of a process and an apparatus are claimed for the conversion of hydrocarbons into gasoline of high anti-

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knock value in the presence of catalyst particles impregnated with metal oxide and dispersed in a portion of the fluid hydrocarbons, and for the regeneration of the catalyst.

U.S.P. 2,462,384. Recovery of Products of Hydrocarbon Conversion Reactions. M. H. Gorin and W. Swerdloff to Socony-Vacuum Oil Company, Inc.

The invention relates to low temperature hydrocarbon conversion processes (alkylation, isomerization, reforming and the like) which are carried out with the aid of hydrocarbon soluble catalysts, such as $AlBr_3$. Details of a method are claimed for the ready separation of product and catalyst and for recycling of the latter.

U.S.P. 2,462,390. Method of Preparing Aqueous Emulsions of Polyethylene. J. Harmon to E. I. duPont de Nemours & Company.

Ethylene is polymerized at a pressure of 200-1000 atmospheres in intimate contact with a buffered aqueous 3-20 per cent solution of an alkali persulfate with a pH of 7.5-11. The reaction is continued until absorption of the ethylene ceases. The polyethylene is obtained in the form of a stable dispersion, the sole stabilizing agent thereof being the surface active agent formed in situ during the polymerization process.

U.S.P. 2,462,678. Catalysts for Polymerizing Olefins. M. J. Roedel to E. I. duPont de Nemours & Company.

A monoolefin with not more than 4 C atoms, particularly ethylene, is polymerized under pressures of 4-3000 atm. in the presence of 0.001-5 per cent of an oxime, such as acetone oxime.

U.S.P. 2,462,891. Contact Conversion of Hydrocarbons. H. D. Noll to Houdry Process Corporation.

Hydrocarbon material at least partially in the liquid phase is contacted with a downwardly moving non-turbulent bed of relatively inert granular fluent solid of a temperature higher than that of the hydrocarbon material. Hot hydrocarbon vapors produced by direct heat exchange between these materials are separated from the solid and converted in contact with a downwardly moving non-turbulent bed of fluent granular conversion catalyst at conversion temperature. Coked catalyst from this conversion zone commingled with a downwardly moving non-turbulent bed of the inert solid from the contacting zone is contacted with an oxidizing gas to regenerate the catalyst and to heat the inert solid and catalyst by means of combustion of the coke deposit. The heated inert fluent solid is then separated from the regenerated catalyst, for example on the basis of different particle size, and both solids are recycled to their respective zones.

U.S.P. 2,463,225. Polymerization of Dienes. J. R. Vincent to E. I. duPont de Nemours & Company.

1,3-butadienes are polymerized in the presence of 0.05-10 per cent (of their weight) of a modifier of the formula $R\text{-}CI_3$ in which R is -H, I, or $-CH_3$, such as iodoform. Rubber-like products are obtained.

U.S.P. 2,463,596. Process of Preparing

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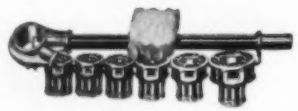

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Polycyclopentadiene in the Presence of a Haloalkene. G. B. Buttler to Rohm & Haas Company.

Cyclopentadiene is dissolved in one of the following 2-haloalkene-1 compounds: 2-chloropropene, 2-chlorobutene-1, 2-bromopropene, 2-bromopentene-1, and 2-iodopropene, and is then polymerized at a temperature of -80° to +25° C. with a catalyst composed of $SnCl_4$, $AlBr_3$, $AlCl_3$, BCl_3, or HF_3.

U.S.P. 2,463,623. Apparatus for the Conversion of Fluid Reactants. L. C. Huff to Universal Oil Products Company.

The details of an apparatus are claimed for the conversion of hydrocarbons in the presence of catalyst particles transported by a gas-lift. It makes possible continuous circulation and regeneration of the solid catalyst particles. Incoming fluid reactants and/or incoming regenerating gas are employed as the transporting media for the catalyst particles.

U.S.P. 2,463,729. Pyrolytic Conversion of Hydrocarbons. K. M. Watson to Sinclair Refining Company.

In a fluid catalyst process for the conversion of hydrocarbons, the suspension of catalyst and hydrocarbon vapors is passed upwardly through a succession of vertically spaced zones of the conversion chamber. These zones are delineated by perforated partitions, each of which holds a bed of catalyst. Details of the process are described in the claims.

U.S.P. 2,463,866. Process for the Production and Recovery of Olefinic Elastomers. A. D. Green to Standard Oil Development Company.

A mixture of isobutylene and an organic non-reactive diluent which remains liquid at polymerization temperature (e.g. methyl chloride) is continuously supplied to a reaction zone where it is maintained at a temperature between —40° and —160° C. with continuous addition of a Friedel-Crafts catalyst. A slurry of solid polymer particles in cold reaction liquid is formed. The cold slurry is discharged in a quenching zone into a heated, agitated aqueous liquid in order to flash off the volatile reaction liquid and separate the polymer particles. Copolymers can be obtained by the addition of di- or polyolefins to the isobutylene.

CATALYST PREPARATION, ACTIVATION AND REGENERATION

U.S.P. 2,461,838. Solid Bed Catalyst Regeneration Process. F. C. Neuhart to Phillips Petroleum Company.

A major portion of the carbonaceous contaminant of spent solid catalyst from a hydrocarbon conversion is removed by combustion in a relatively narrow burning zone progressing through the entire length of the catalyst mass at about 700° F. in the presence of a regenerating gas containing only a small amount (e.g. 2 per cent) of oxygen. The temperature is thereafter raised to at least 1100° F. and the passage of the regenerating gas is continued for a period of time sufficient to complete the regeneration.

U.S.P. 2,462,193. Catalyst Regenerator and Recovery Apparatus. W. E. Hulsberg to Universal Oil Products Company.

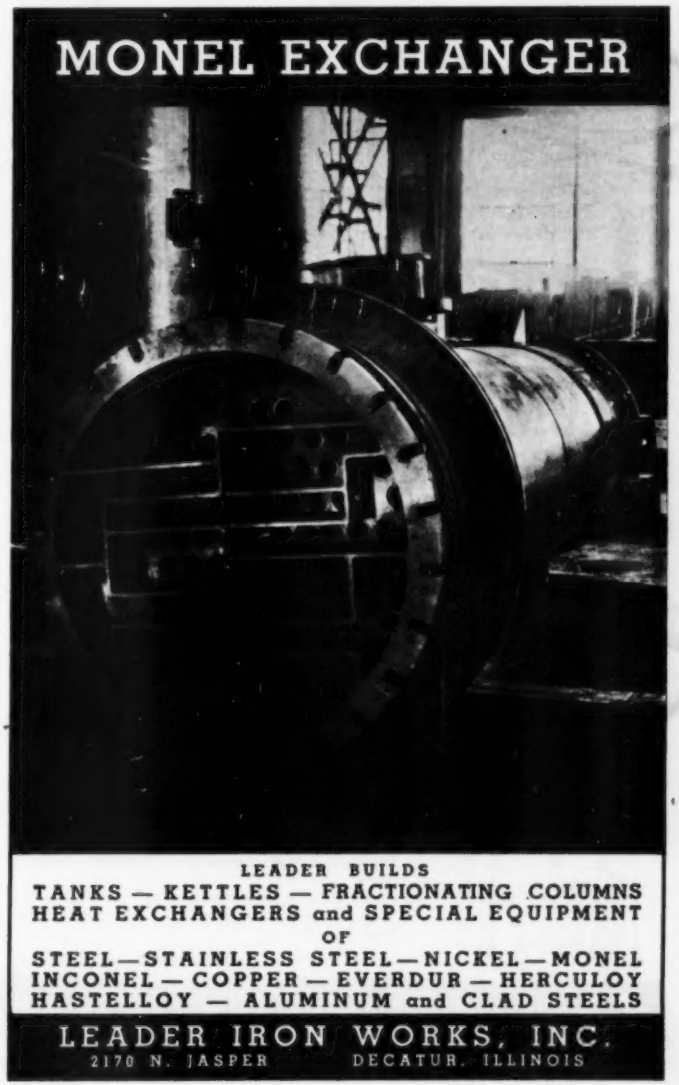
An apparatus for the regeneration and recovery of fluidized catalyst particles is described. It combines within one unit an internal chamber for catalyst regeneration, a steam generating zone, and a flue gas scrubbing zone housed in annular spaces surrounding the regenerating chamber. Particulars of this apparatus are claimed.

U.S.P. 2,462,236. Manufacture of Silica Hydrogel and Catalysts. C. L. Thomas to Universal Oil Products Company.

An alkali metal silicate is commingled with an acid in the amount necessary to form the corresponding hydrogel in an alkaline medium. The pH of the mixture is then reduced to below 5 by further addition of acid. A basic reagent is added thereafter to raise the pH of the mixture to 5-8. This control of the pH substantially accelerates the formation of silica gel at room temperature. The resulting silica hydrogel can be combined with a metal oxide to form a catalytic composite.

U.S.P. 2,462,739. Recovery of Hydrogen Fluoride-Boron Trifluoride Catalysts. W. F. Gresham to E. I. duPont de Nemours & Company.

HF-BF_3 catalysts, as employed in the production of aromatic aldehydes from aromatic hydrocarbons by reaction with CO, are separated from their mixture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with these aldehydes, such as benzaldehyde, by adding an alkali metal or alkaline earth metal fluoride, e.g. LiF, to this mixture. A precipitate containing combined HF and BF_3 and metal fluoride is obtained. HF and BF_3 are recovered from this precipitate by pyrolysis at a temperature of 200-800° C.

U.S.P. 2,462,861. Regeneration of a Hydrocarbon Synthesis Catalyst. R. C. Gunness to Standard Oil Company (Indiana).

Spent Fischer-Tropsch synthesis fluidized iron catalyst is contacted at combustion temperature with an oxygen-containing gas. The oxidation is continued until the C-content of the catalyst is reduced to 5-10 per cent of the catalyst weight. The catalyst is then reactivated by hydrogen treatment at a temperature above 500° F.

U.S.P. 2,463,072. Manufacture of Catalysts. G. M. Webb and M. A. Smith to Universal Oil Products Company.

A solution containing an Al-salt in which the Al is a cation and a compound of another metal in which the metal is an anion and which contains a volatilizable cation is mixed with a volatile basic precipitant (e.g. NH_4OH) in sufficient amount to bring the pH to at least four. Alumina hydrate is precipitated and a readily volatilizable salt is formed from the acid radical of the Al-salt and the precipitant. The reaction mass is dried and then heated to convert the compound of the other metal to the oxide. Metals of the left-hand columns of groups V and VI of the periodic table can, for example, be employed in said metal compounds.

U.S.P. 2,463,115. Heated Catalyst Chamber. H. R. Legatski to Phillips Petroleum Company.

An electrical heating apparatus is claimed which can be installed in and automatically or manually operated in conjunction with a dehydrogenation catalyst chamber in order to prevent a temperature drop of the catalyst due to endothermic dehydrogenation reactions.

U.S.P. 2,463,204. Recovery of Sludge Acids. G. T. Reich.

Sludge acid, as obtained in the treatment of petroleum oils with H_2SO_4, is concentrated under vacuum to a concentration having a boiling point at atmosphere pressure substantially above its temperature of charring. The acid is then heated at atmospheric pressure and a temperature at least as high as its charring temperature but substantially below its b.p. until charring is complete. The resulting acid is mixed with a substantial proportion of H_2SO_4 of about the same concentration, and the carbonaceous material is removed.

U.S.P. 2,463,228. Silver Surface Catalysts and Process of Producing Same. T. J. West and J. P. West to Allied Chemical & Dye Corporation.

A silver surface catalyst for use in producing olefin oxides directly from olefins is prepared by co-precipitating Ag_2O and silver halide in the proportions of .03-3 per cent silver halide by weight of Ag_2O and reducing the co-precipitated silver compounds with ammonia.

U.S.P. 2,463,434. Treatment of Fluidized Solid Catalyst. R. V. Shankland to Standard Oil Company (Indiana).

In the conversion of hydrocarbons in the presence of fluidized solid catalysts of 50-350 mesh, regenerable at a temperature of 950-1200° F., volatilizable hydrocarbons are removed from the spent catalyst by countercurrently stripping with steam. The major part of the steam and volatilized hydrocarbons is separated from the catalyst and the residual steam is then displaced from the stream of catalyst by countercurrently contacting it with a moisture-free, inert stripping gas, such as spent regeneration gas. The stripped, moisture-free catalyst is then introduced into the regenerating zone.

U.S.P. 2,463,508. Catalyst and Process for Hydrocarbon Conversion. J. R. Bates to Houdry Process Corporation.

In the conversion (e.g. cracking) of hydrocarbons a contact mass is employed which contains a major proportion of silica, a minor proportion of alumina, and 1/15 per cent of manganese oxide and is prepared from a composite of moist undried hydrous oxides of Si, Al, and Mn. This composite can be obtained by coprecipitation.

U.S.P. 2,464,127. Methods of Activating Acid Activatable Clays. W. W. Gary to Filtrol Corporation.

The details of a method are claimed for activating clays, such as sub-bentonite of montmorillonite structure, by

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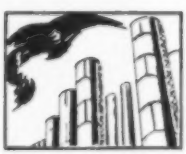

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treatment with 40-125 pounds (calculated as anhydrous) of H_2SO_4 per 100 pounds of the clay.

Corrosion Group Organizes Inter-Society Committee

The Inter-Society Corrosion Committee of the National Association of Corrosion Engineers was recently organized by delegates and observers from technical organizations concerned with corrosion. The committee will carry on activities of the former American Coordinating Committee on Corrosion and the NACE Committee on Relations with Other Technical Societies.

Objectives of the committee are to promote cooperation among various technical societies working in the field of corrosion, to prepare and publish periodically a directory of corrosion workers in the United States, to provide liaison among technical committees of NACE and other technical societies, to act in advisory capacity to technical societies interested in corrosion in an effort to promote progress of all and avoid duplication of effort, to recommend in which society a proposed new activity might be carried out best without attempting to define or limit the field of activity of any society, and to stimulate the publication of reliable data on corrosion and to provide publicity for conferences in this field.

New Laboratory Methods Determine Crude Oil Source

New laboratory methods have been developed to enable the Pennsylvania Grade Crude Oil Association to determine whether a specific lubricating oil sample is derived from a Pennsylvania or a non-Pennsylvania crude oil source.

The methods developed at Armour Research Foundation make use of scientific procedures called infrared transmission, bromine number and refractivity intercept. They supplement one of the first methods used for the identification of Pennsylvania oils, based on optical rotation and developed at The Pennsylvania State College.

ACS Technical Classes Slated in Philadelphia

The Philadelphia section of the American Chemical Society will again sponsor special non-credit courses designed to advance the training of chemists in the area. Open to both members and non-members of the society, the courses this spring will include sulfur chemistry, process control and research administration.

Information may be obtained from Dr. J. F. Gall, Whitemarsh Research Laboratories, Pennsylvania Salt Manufacturing Company, Wyndmoor, Pa.

Gulf Gives Service Awards

Gulf Oil Corporation is presenting certificates and jeweled emblems this spring to 3297 employes who have completed their first ten, or a subsequent five, year term of service. This marks the tenth annual service award presentation since inception of the program in 1939; and to date, 19,485 veteran employes have been honored.

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Be sure to get your copy of Catalog 61 which contains an illustrated description of RATO-CHLOR dispensers now used in more than 100 installations.

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BOOKS of Interest

Steel Plate Reference Book Published by Lukens Steel

"Steel Plates and Their Fabrication," a reference book for engineers and designers, has been published by Lukens Steel Company. Lionel S. Marks, Gordon McKay professor of mechanical engineering, Emeritus of Harvard University, is editor.

Selecting plates for projects and analyses of physical properties of carbon and low alloy steels, as well as information on nickel-, stainless-, inconel- and monel-clad steels is presented in the book. General engineering information, including mathematical and conversion tables is covered and charts, graphs, isometric drawings and photographs of steelmaking and fabricating operations are shown. Historical data and information on open hearth steelmaking, welding, the effect of plate widths on fabrication costs, strength of flat plates and shells, forming, flanging, pressing, flame-cutting, fabricated assemblies, pressure vessels and tanks is also included.

Request handbook on company letterhead, addressing Lukens Steel Company, 107 Highway Building, Coatesville, Pa.

Testing Society Offers New Books, Appendices

The 1948 compilation of *ASTM Standards on Petroleum Production and Lubricants*" gives, with few exceptions, all of the test methods and the other special standards developed by Committee D-2 on Petroleum Products and Lubricants of the American Society for Testing Material. In addition to the annual report of the committee, proposed methods for other materials are given in several appendices.

Methods of tests for knock rating of engine fuels, which were outlined in the *ASTM Manual of Engine Test Methods for Rating Fuels*, will be brought up to date in a 1948 appendix to the manual. Changes and improvements made in the test methods will also be given.

A copy of the 1948 compilation of standards may be had from the ASTM headquarters, 1916 Race Street, Philadelphia 3, at $5.50 per copy bound in heavy paper and $6.15 per copy bound in cloth. The ASTM manual is $8.00 per copy and its 1948 appendix is $1.00 per copy.

Catalysts, Fischer-Tropsch Process in Bureau Report

Production of synthetic liquid fuels by the Fischer-Tropsch process and Bureau of Mines research on catalysts used in the process are described in Technical Paper 709, for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C., at a cost of 50 cents each.

The publication reviews research in Germany, and discusses the industrial development of hydrogenation of carbon monoxide there as well as Japan, Great Britain, Italy, Australia, Scotland, Spain, Canada and the U. S. Also included are a record of experimental work done by the Bureau between 1943-1946 on the effect of mode of catalyst preparation, reduction and induction on activity in the synthesis and on the boiling range of the product and results of catalyst-testing experiments, correlations of physical properties of catalysts with their activity and an appendix on the preparation of catalysts.

Instrument Society Offers 2 Recommended Standards

Tentative recommended practice, RP1.1, "Coding of Thermocouple Wire and Extension Wire," has been prepared by the Instrument Society of America to bring about greater uniformity in the instrumentation field. Tables give recommended symbols for the following thermocouple combinations and extension wire: Iron—Constantan (types J and Y); Chromel—Alumel; Platinum—10 percent Rhodium-Platinum; Platinum—13 percent Rhodium-Platinum and Copper—Constantan. Price to non-members is $1.

Recommended practice RP2.1, "Manometer Tables," presents abbreviations and fundamental conversion factors commonly used in manometry, recommended definitions of pressure in terms of a column of mercury and water and a large number of various temperatures. Price to non-members is $2.

Standards are available from the National Office of the Instrument Society of America, 1117 Wolfendale Street, Pittsburgh 12. Checks in New York bank funds must accompany the order.

Legal History Prepared by American Bar Association

"Conservation of Oil and Gas, A Legal History," published by the mineral section of the American Bar Association, summarizes the legislative, administrative and judicial activities of each producing state and presents its conservation records. The volume, edited by Blakely M. Murphy, professor of law at the University of Tennessee, brings up to date the legal history published by the association in 1938.

The book is divided into four parts: 1) Fundamentals of Reservoir Behavior that Relate to the Conservation of Oil and Gas, 2) Legislative, Administrative and Judicial Concepts of Oil and Gas Conservation as Applied Within the Jurisdiction of the States, 3) The Interstate Compact to Conserve Oil and Gas and Its Administrative Arm—The Interstate Oil Compact Commission and 4) The National Government and the Conservation of Oil and Gas.

Studies of both past and present legislation, whether or not adopted, is included in the book, along with analyses of the orders, rules and regulations of the state agencies and other pertinent judicial information. Developments up to November 10, 1948, have been recorded.

Address Miss Olive G. Ricker, American Bar Association, 1140 North Dearborn Street, Chicago.

Metal Society Issues First of Techbook Series

The first in a series of techbooks, written by outstanding metal engineers, has been issued by the American Society for Metals. The initial volume, "The Story of Magnesium," is authored by W. H. Gross, technical department of The Dow Chemical Company, Midland, Mich. The purpose of the series is to provide men and women who are not engineering graduates, with the technical information needed to properly understand the science of metals as it is applied in industrial production.

"We believe that this and future Techbooks will be suitable for use as self-educational material," W. H. Eisenman, national ASM secretary, said. "The society is vitally interested in making available a simplified interpretation of metal science so that our future generation of metal scientists will early understand and appreciate the importance of the metal scientist. We also believe that these techbooks can and will be used as texts, as a basis for a fundamental lecture series, as supplementary reading for plant courses, and many other uses."

To aid instructors, the charts and illustrations in "The Story of Magnesium" have been made into a film strip which is available at low rental from the publishers. Copies of the book can be obtained from the American Society for Metals, 7301 Euclid Avenue, Cleveland 3, Ohio for $1.50 each.

Books on Patents Explain General, Technical Facts

Harry Aubrey Toulmin, Jr., corporation lawyer with Toulmin and Toulmin, has written two books, "Patent Law for the Executive and Engineer" and "How To Keep Invention Records," on the problems of obtaining and retaining patent rights. Simply written and easy to read, the books have the answers to both general and technical questions. A complete set of invention record forms are presented with each book.

A practical volume and a handy manual to give quick answers to all questions which might arise about patents, "Patent Law for the Executive and Engineer" shows the reader how to develop and protect his inventions so that he can succeed in making them profitable. It teaches him what to do and what not to do so he can earn money from his inventions without interference. Portions of the book have appeared in magazines.

"How To Keep Invention Records" shows the reader how to protect his patent property by keeping records to prove his rights. Important rights discussed are the date of conception, date of disclosure to others to prove he has the invention, reducing to practice by test and experiment to prove it was successful, recording his research results and proving the ordering of materials and experiment for first production runs.

"Law" is $2.95 and "Records" is $2.50 per copy. The publisher is Research Press, Inc., 137 North Perry Street, Dayton 2, Ohio.

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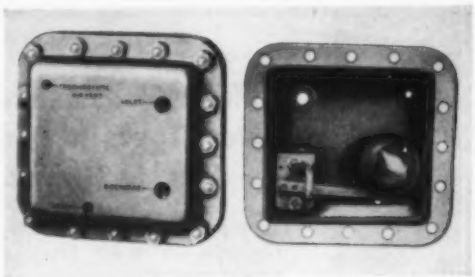
NEW EQUIPMENT and Manufacturers' Literature

For copies of manufacturers' literature or more information on products described on these pages write to the address shown, using the number shown for each item.

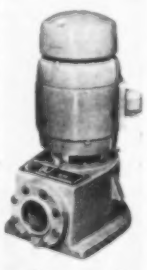
Drain Trap



The new continuous flow drain trap, manufactured by W. S. Rockwell Company, can be incorporated into steam storing or conditioning equipment which depends on rapid, complete drainage of condensate or foreign matter. The steam, gas or air condensate mixture entering the trap above the condensate is regulated by a slide valve and float mechanism. The outlet valve seals when there is no condensation taking place. Material is removed from the trap by moving the drainage lever on the cover. Movement of the slide valve vertically over the orifice with the rising or lowering of the float, "helps prevent short-circuiting of vapor, while the cutting action of the slide continuously frees the valve orifice of sludge or other foreign matter in the line. There is no valve seat wear." Available in screwed or flanged types for ½, ¾ and one-inch pipe sizes, for pressures of 150 and 300 psi and temperatures up to 750° F., the trap has interchangeable orifices.

For further information write W. S. Rockwell Company, 200 Eliot Street, Fairfield, Conn., referring to PETROLEUM REFINER item **206.**

Centrifugal Pumps



Byron Jackson Company has redesigned its line of Deepwell centrifugal pumps. Henry Dreyfus, industrial designer, collaborating with company engineers on the redesign. The basic principles in the first pumps remain, but "refinement and construction improvements have increased efficiency and lowered the cost." Access for maintenance and lubrication have been improved. Three assembly sizes fit wells from 6 to 24 inches or larger. Several impeller designs are standard for each size in the three bowl types and the pumps have more than 100 individual impeller designs of varying hydraulic characteristics.

For further information write Byron Jackson Company, Terminal Annex, P. O. Box 2017, Los Angeles 54, referring to PETROLEUM REFINER item **207.**

Single-Phase Motors

The new line of integral horsepower, single-phase electric motors, developed by The Louis Allis Company, is available in open drip proof, splash proof, totally enclosed, fan cooled and explosion proof construction. The centrifugal switch formerly used to disconnect the starting condensers from the line after the motor is up to speed has been replaced by a voltage relay mounted in the control cabinet supplied with the motor. The cabinet also includes an across-the-line starter and the necessary capacitors which makes possible the removal of the capacitor enclosure on the motor itself. These new motors are built in capacitor start-induction run types in ratings of 1 and 1.5 hp and in capacitor start-capacitor run types in ratings of 2, 3, 5, 7.5 and 10 hp.

For a copy of Bulletin 722 write The Louis Allis Company, Milwaukee 7, Wis., referring to PETROLEUM REFINER item **208.**

Standard Steel Lists

Standard steel lists combined in one data folder and offered by The Babcock & Wilcox Tube Company, give chemical compositions for basic open-hearth and acid-bessemer carbon steels and resulphurized steels, for open-hearth and electric-furnace alloy steels and for stainless and heat-resisting steels, all subject to standard variations for check analysis. Showing the AISI number with the SAE number, these are convenient lists for cross reference.

For a copy of technical data card 119 write The Babcock & Wilcox Company, Beaver Falls, Pa., referring to PETROLEUM REFINER item **209.**

Air-Cooled Heat Exchanger

Featuring the applications of the Fin-Fan air-cooled heat exchanger, the March issue of G-R News, published by The Griscom-Russell Company, describes the design of this unit. Typical installations inside a building, on a roof and on the ground are shown with explanation of the reasons for the unusual adaptability of these units.

For a copy write The Griscom-Russell Company, 285 Madison Avenue, New York 17, referring to PETROLEUM REFINER item **210.**

Magnesium Anodes

Electrical ratings, weights, sizes and forms of various magnesium anodes for cathodic protection of pipe lines and other metal structures is presented in a Dowell bulletin.

For a copy write Dowell Incorporated, Kennedy Building, Tulsa 3, referring to PETROLEUM REFINER item **211.**

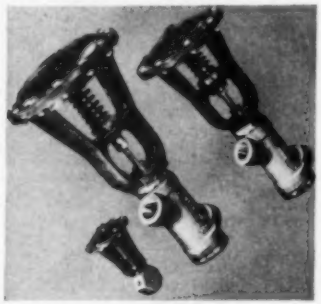
Thermal Switch

The Microsen thermal switch, developed by Manning, Maxwell & Moore, Inc., operates from a thermocouple input to signal temperature variations in heating processes. The signal output is given by electrical relay action. On and off switching of 10 amperes at 115 volts a. c. or 32 volts d. c. directly is possible for any temperature setting from 100° to 2000° F. Larger electrical loads can be switched by means of intermediate relays. Featuring a plug-in arrangement for the entire chassis and working parts, the switch has a 6SN7 vacuum tube operating in conjunction with the Microsen balance and a precision relay. According to the manufacture, the instrument is designed for two percent

operating accuracy and failure of any component will cause the relay circuit to open.

For further information write Manning, Maxwell & Moore, Inc., Bridgeport 2, Conn., referring to PETROLEUM REFINER item **212.**

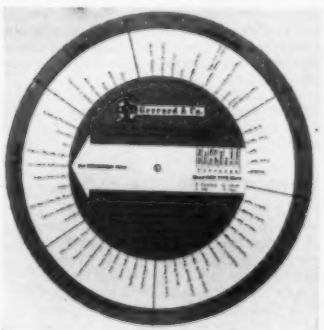
Low-Pressure Valves



Recommended for handling viscous materials and for applications requiring quick heating and cooling, the new line of diaphragm-actuated D-113 Merit low-pressure valves, offered by Emmett Machine and Manufacturing, Inc., can be mounted either vertically or horizontally. Sizes range from ¼ to 3 inches with maximum pressures either 300 to 500 psi. Stems, seats and discs are "highly resistant to corrosion and serve to minimize electrolysis, seat ring areas exceed standard pipe areas and permanent disc and stem assembly as well as seat rings are interchangeable among the three assembly types." Exhaust side of the three-way valves is one pipe size larger than nominal.

For further information write Emmett Machine and Manufacturing, Inc., 2249-56 Fourteenth Street, S.W., Akron 14, Ohio, referring to PETROLEUM REFINER item **213.**

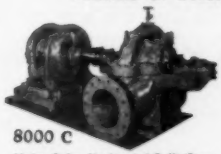
Anti-Corrosion Strap Selector



Anti-corrosion straps and special application tools to bind insulation to piping in process are being marketed by A. J. Gerrard & Company under the trade name of Steelbinder Strapping. As part of its program of educating plant men in the proper selection of strapping for various conditions, the company offers an "Anti-Corrosion Strap Selector." An arrow on the selector is moved to point to the type

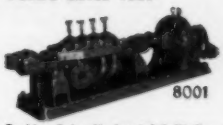
PUMPS

BUILDERS OF OUTSTANDING PUMPS SINCE 1869



8000 C

Motor Drive Horizontal Split Case Double Suction Centrifugal Pump

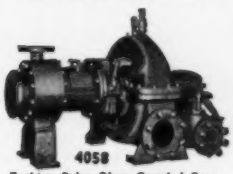


8001

Turbine Drive Horizontal Split Case Multi Stage Centrifugal Pump

4049 A

Two Stage Close Coupled Centrifugal Pump



4058

Turbine Drive Close Coupled Centrifugal Pump

942

Single Style, Packed Piston Pattern Steam Pump

2352 B

Durable Duplex, Outside End Packed, Plunger Pattern Steam Pump

3918

Durable Duplex, Packed Piston Pattern Steam Pump

3833

Horizontal Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump

ESTABLISHED 1869

DEAN BROTHERS PUMPS INC.

INDIANAPOLIS IND.

323 W. TENTH ST.

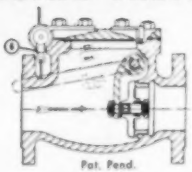
SAFEGUARD your plant against... FIRE

FALCON-GREENWOOD

SAFETY QUICK CLOSING VALVE

Will instantly stop the flow of inflammable liquids or gases. Automatic control through fusible link (6) or remote or manual control from any point in the plant.

Don't gamble with fire in your plant or on your rig. Fire arrested in time saves lives, equipment, money.



Install FALCON-GREENWOOD Safety Quick Closing Valves on your present equipment. Plan them into your new construction. Built of cast steel for high pressure. Monel or stainless steel trim on order. Send for bulletin, dimensions and prices.

Another FALCON-GREENWOOD Product

FALCON-GREENWOOD

Non-Chattering • Free Flow

SWING CHECK VALVE

Here at last is a patented swing check valve that won't knock or chatter. Will outlast ordinary check valves many times. Gate mounted on vertical pin instantly swings into closed position when flow ceases or is reversed. Each valve factory tested.

GET BULLETIN 105 for full details on above Valves.

FALCON PRODUCTS, INC.

POMONA, CALIFORNIA

BRANCH WAREHOUSES: HOUSTON, ODESSA, WICHITA FALLS, TEXAS
OKLAHOMA CITY, OKLA. • SHREVEPORT, LA. • BAKERSFIELD, LONG BEACH, CALIF.

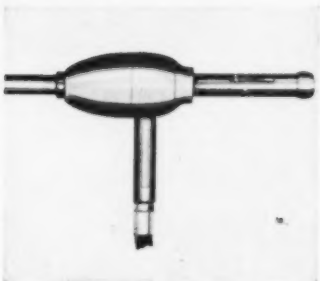
Export Representative: Guy E. Daniels, 30 Rockefeller Plaza, New York 20, N. Y.

of chemical condition, atmospheric environment, soil, water or gas fumes to which the strapping will be exposed. An opening in the butt section of the arrow indicates the strap metals which will give good service under the specified condition.

The selector is designed to cover virtually every type of service condition to which metal strapping may be exposed. Its use simplifies selection of the right strap from the seven materials in which Steelbinder Strapping is available. The selector includes a calculator for determining the length and weight of steel or aluminum strapping required for any given binding operation.

The selector-calculator may be obtained free by addressing A. J. Gerrard & Company, 1950 North Hawthorne Avenue, Melrose Park, Ill., referring to PETROLEUM REFINER item **214.**

Tube Cutter

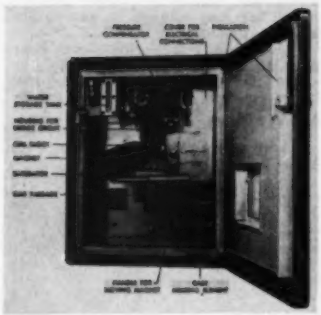


Development of a new condenser tube cutter, internal type, has been announced by Airetool Manufacturing Company. It is designed for use with condenser tubes in sizes from ½ to 1½ inches in diameter. Made of alloy steel with a blade of tool steel, the cutter is equipped with an air line "for blowing cuttings out, to prevent jamming and to keep the tool bit cool." The operator controls the tool bit and cutting speeds. Recommended for use in cutting both ferrous and nonferrous tubes and for the removal of bimetal tubes, the tool cuts through tube sheet thicknesses from ½ to 6 inches. Spacing collars are supplied for various sheet thicknesses.

For further information write Airetool Manufacturing Company, Springfield, Ohio, referring to PETROLEUM REFINER item **215.**

Oxygen Meter

Magno-Therm, the oxygen meter manufactured by The Hays Corporation, operates on a principle based on the paramagnetic property of oxygen. It continuously analyzes, indicates and records the percentage of oxygen in boiler flue gases and in industrial gases. Gas to be analyzed is passed through a cell block in which there are two cells containing heated resistors. The sample gas diffuses into the cells and a magnetic field from a permenent magnet is directed across one. Attracted into the magnetic field, the gas becomes heated by the hot resistor. The oxygen loses its magnetism as it becomes heated and is forced out of the magnetic field by the cooler more magnetic oxygen. The cooling effect on the heated resistor is proportional to the magnetism of the gas



entering the cell. This changes its electrical resistance and increases the flow of current through it. The change in flow of current is compared with the flow of current in the comparison cell resistor (without a magnetic field) and the difference in resistance is measured by the Hays acratron electronic type recorder, calibrated to read in percent oxygen. The measurement is compensated for ambient temperature, barometric pressure and variable moisture content of the gas sample. The temperature of the analyzing cell is claimed to be too low to support a combustion and the presence of hydro-carbon gases and vapors does not affect the accuracy of the instrument.

For further information write The Hays Corporation, Michigan City, Ind., referring to PETROLEUM REFINER item **216.**

Faceshield

Face protection with unobstructed vision is provided to workers handling ecids, chemicals, pouring metal, doing sanding, light grinding, degreasing and similar operations, by the deluxe faceshield, manufactured by Mine Safety Appliances Company. The shield consists of a large area visor (19 inches wide and 9 inches deep) of non-inflammable vinyl plastic which extends around the face, covering the ears and reaching below the chin. It is available in thicknesses of .020, .040 and .060 inches. The visor is snap-fastened to a hard fiber sparkguard. An adjustment knob makes the headgear fit any head size.

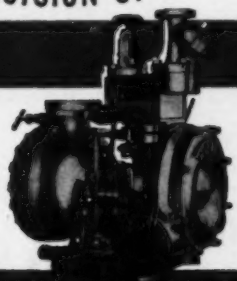
For a copy of Bulletin CN-2 write Mine Safety Appliances Company, Braddock, Thomas and Meade Streets, Pittsburgh 8, referring to PETROLEUM REFINER item **217.**

Manifold Valve

Betts Machine Company announces a special manifold valve which "permits free-flowing of oil and other liquid materials with less loss of head." This valve has large flow areas, giving fast flow of materials. The manufacturer claims there is no chance of leakage because of the use of seamless steel

COFFIN

Turbo Pumps Deliver 3-to 12-Stage Pump Performance



COFFIN PUMP REPRESENTATIVES SERVE ALL OF AMERICA'S INDUSTRIES

L. O. Arringdale, New York, N. Y.
Robert Bacon Company, Newton, Massachusetts
Beeson Bros. Engineering Co., Los Angeles, California
Stuart D. Brown, Sewickly, Pennsylvania
The H. Berry-Detroit Company, Detroit, Michigan
Cordes Brothers, San Francisco, California
J. M. Costello Supply Co., Wilmington, California
John N. Fehlinger Co., New York, N. Y.
Fuel Economy Engineering Co., Saint Paul, Minnesota
J. W. Himmelsbach, Chicago, Illinois
International Railway Supply Co., New York, N. Y.
C. E. Johnson & Associate, Atlanta, Georgia
William F. Lewis, Kenmore, New York
Maleson Company, Philadelphia, Pennsylvania
John H. Marvin Co., Seattle, Washington
John H. Marvin Co., Portland, Oregon
The O'Fallon Co., St. Louis, Missouri
Charles Ostertag, Indianapolis, Indiana
Henry P. Thompson Co., Cincinnati, Ohio
P. Thompson Tool & Supply Co., Houston, Texas
Frank D. Riggio Co., Rutherford, N. J.
Seaboard Equipment Co., Yarmouth, Maine
William P. Little, Bridgeport, Conn.
Warren M. Wilson Co., Cleveland, Ohio
Marine Specialty Co., Mobile, Alabama
P. Thompson Tool & Supply Co., New Orleans, Louisiana

A complete 4-page illustrated bulletin on COFFIN TURBO PUMPS with all operating data, applications, specifications, that you may require for your next job. Write for Bulletin "S" today.

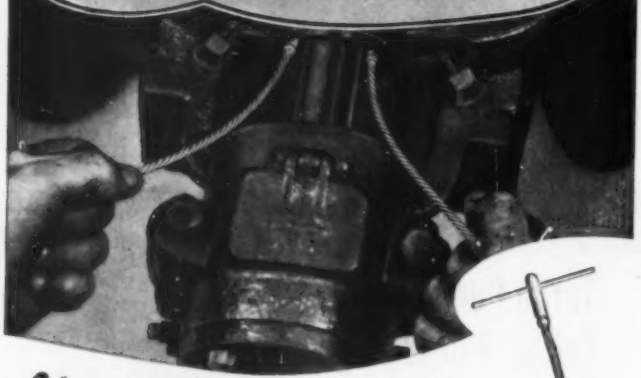
165

COFFIN

The J. S. COFFIN, JR., COMPANY

326 SOUTH DEAN STREET, ENGLEWOOD, NEW JERSEY

Remove Packings THIS BETTER WAY



Use DURA HOOKS

Sturdy ALL STEEL Packing Pullers

HERE is a time saving device for removing old packing from stuffing boxes that will improve your man-power efficiency. DURA HOOKS are rugged, flexible hand-tools that can be used in "hard-to-get-at" places. For best results use two hooks as shown in illustration. Order your requirements to-day . . .

DURA HOOKS - HANDY SETS

Set No.	Description	Price
Set AA	Consists of 3 pairs of hooks, 7½", 11" & 15" in length. For use in packing spaces ¼" to ½" incl.	$ 10.00
Set BB	Consists of 4 pairs of hooks, 7½", 11", 15" & 19" in length. For use in packing spaces ¼" to ⅝" incl.	17.00
Set CC	Consists of 5 pairs of hooks, 7½", 11", 15", 19" & 22" in length. For use in packing spaces ¼" to 1" incl.	25.00
Set DD	Consists of 6 pairs of hooks, 7½", 11", 15", 19", 22" & 30" in length. For use in packing spaces ¼" to all over 1 inch.	37.00

ABOVE PRICES U.S. ONLY . . . ASK YOUR JOBBER OR ORDER DIRECT FROM FACTORY

The PERFECT SEAL

DURAMETALLIC CORPORATION
KALAMAZOO MICHIGAN

MANUFACTURERS OF METALLIC and SEMI-METALLIC PACKINGS
ROTARY MECHANICAL SEALS and PACKING TOOLS

tubing and stamping. Valve arrangements "are easy to apply to any designer's requirements."

For further information write Betts Machine Company, Warren, Pa., referring to PETROLEUM REFINER item **218.**

Arc Welders

Featuring increased welding range and stepless precision current control, the new line of a-c arc welders of General Electric Company are available in 200, 300, 400 and 500-amp models for indoor manual welding; 750 and 1000-amp models for machine and submerged melt welding; and a 200-amp model for light-duty, job-shop welding. The 300, 400 and 500-amp models are offered also in weather-resistant enclosures with Idlematic control for both indoor and outdoor operations. Duel current ranges and increased adjustment overtravel provide "extra low current range with high maximum short-time output." The welders have an open-circuit voltage of 75 volts and the Idlematic controls on the weather-resistant models automatically reduce the open circuit voltage on the electrodes to about 30 volts. When the arc is struck the advantage of 75 volt, open-circuit voltage is retained. Cool operation is attained by up-draft, fan-assisted ventilation.

For further information write General Electric Company, Schenectady 5, N. Y., referring to PETROLEUM REFINER item **219.**

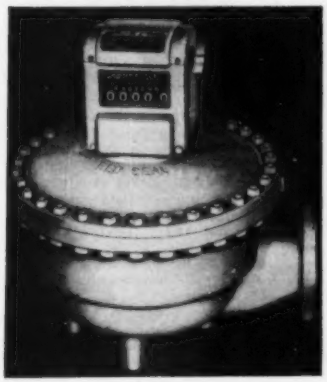
Vertical Air Discharge Units

Young Radiator Company has expanded its line of water and oil cooling equipment with four vertical air discharge models, the HC units. The units feature horizontal coils mounted above the fans, each two coils requiring one fan. Radiator type cores for water cooling or round tube cores for oil cooling are standard equipment with the HC units. Cooling air is blown upward through the coils and vertical discharge eliminates loss of cooling capacity. Requiring 2, 4, 6 and 8 coils respectively, the four units have water cooling capacities ranging from 300,000 Btu. per

hour to 4,320,000 Btu. per hour. Oil cooling capacities range from 99,000 Btu. to 1,570,000 Btu. Horse power requirements range from 1 to 6 hp. per fan.

For further information write Young Radiator Company, Racine, Ill., referring to PETROLEUM REFINER item **220.**

Meter Registers



With resetting and ticket printing done simultaneously by only one handle and with push-button Auto-Stop settings, the new Neptune "Red Seal" meter registers deliveries of petroleum products. Simplest of four types, which are adaptable to any Red Seal meter, is the direct reading reset counter with totalizer. The second type adds the auto-stop feature, providing automatic deliveries. The third type is the "Print-O-Meter," which prints a receipt ticket showing gallonage delivered. The fourth type combines the auto-stop and the Print-O-Meter features. The Neptune Red Seal change gear shifter permits sensitive calibration in steps of about 0.15 percent and will not drift out of adjustment.

For further information write Neptune Meter Company, 50 West 50th Street, New York 20, referring to PETROLEUM REFINER item **221.**

Hose Accessories

A new catalog published by Hose Accessories Company describes Le-Hi's line of hose couplings, hose clamps, air valves and manifolds. Featured in the section on universal type quick detachable air hose couplings is a safety-locking universal coupling with exclusive self-locking springs. Also described are throttle valves for compressed air service, air hammer hose couplings, special high pressure couplings, long shank couplings for low pressure steam and spray hose and hose clamps.

For a copy write Hose Accessories Company, 17th and Lehigh, Philadelphia 32, referring to PETROLEUM REFINER item **222.**

Steam Jacketed Valve

For the transmission of viscous materials which congeal or harden and will not flow at ordinary temperatures, Everlasting Valve Company has developed a steam jacketed valve. The valve disc is designed so that it slides across the ports in a rotating self-clearing action. When wide open, the valve offers straight

ACID GOT THE BITE ON YOU?

-pack it away with

PALMETTO'S SUPER-CUTNO

Built to take the punishment of sulphuric, nitric, mixed, heavy and other acids — and service on all acid-handling pumps and valves. Select long fibre pure blue asbestos . . . each strand impregnated with special acid-resisting self lubricant. Will not score, overheat, or nitrate. Plaited, twisted, ring.

Let Palmetto Blue Asbestos also take the bite out of acid problems as pressure-bonded Sheet, as Dry Blue Rope.

• **Write for full particulars on the *entire* Palmetto line of packings for all industry.**

GREENE, TWEED & CO.
NORTH WALES, PENNSYLVANIA

Contact your fully-stocked Palmetto distributor on all packing problems . . . ask him about our special tools.

PLATINUM & PALLADIUM CATALYSTS

PLATINUM CRUCIBLES, DISHES AND ELECTRODES AND PLATINUM-CLAD APPARATUS

Write for our descriptive booklet on catalysts R-21

THE AMERICAN PLATINUM WORKS
Refiners and Manufacturers
PRECIOUS METALS SINCE 1875
231 NEW JERSEY R. R. AVENUE
NEWARK 5, N. J.

THEY'RE

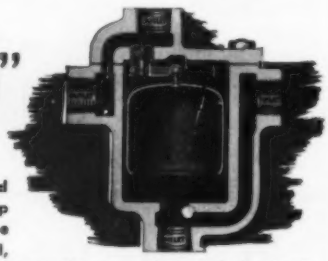
Beating A Pathway To Our Door...

TO GET THAT *BETTER TRAP!*

The Versatile

CLARK "60"

STEAM TRAP



The ever increasing demand for the new CLARK "60" Steam Trap proves that Clark engineers "hit the jackpot" again on this one! It is small, costs less, yet it does *a better job* in *more places* than any other trap in its class!

The CLARK "60" is "the small trap with the big trap features" such as positive seating with guided disc. It is equipped with two inlets and two outlets for easy installation on horizontal or vertical lines.

THE CLARK MANUFACTURING CO.

1847 EAST 38TH STREET • CLEVELAND 14, OHIO

Clark

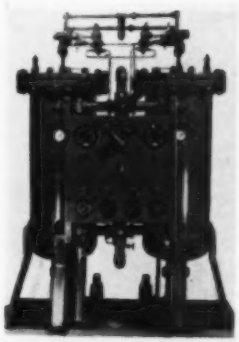
Write today for complete story on Clark Traps and Valves.

TRAPS—FLOAT, INVERTED BUCKET, OPEN BUCKET AND VACUUM • REDUCING VALVES • STRAINERS

through flow with unrestricted passage. All parts move in a parallel plane "so that the mechanism is non-wedging." The steam or other heating medium can be connected to the jacket at either side of the valve. Expansion and contraction due to changes in temperature are claimed to not affect the operation or leak-proof qualities of the valve. The valves are available in 2-, 3-, and 4-inch sizes for 125 psi. line pressure and 125 psi. jacket pressure.

For further information write Everlasting Valve Company, 45 Fisk Street, Jersey City 5, N. J., referring to PETROLEUM REFINER item **223.**

Dynamic Dehumidifier



A new development in automatic dehydration equipment is described in Bulletin DD-100, published by Industrol Corporation. The dynamic dehumidifier is the "result of the application of refinery design standards and methods to the dehydration problem." Designed for instrument air supply service where dependable clean dry air supply is essential, the dehumidifier can also be used to dry other gases for industrial use.

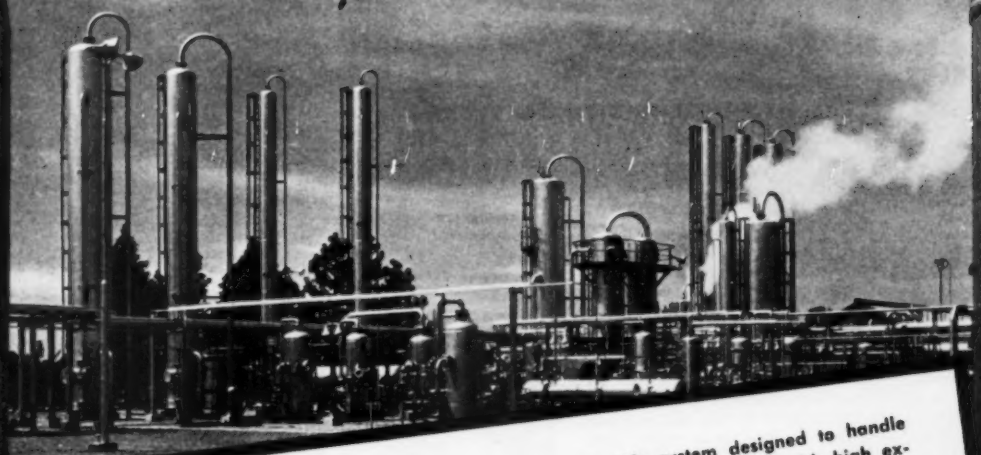
For a copy of the bulletin write Industrol Corporation, 88-35 76th Avenue, Glendale, Brooklyn 27, N. Y., referring to PETROLEUM REFINER item **224.**

Measuring Coating Thickness

The "Coatingage," an instrument for measuring the thickness of non-magnetic coatings on iron or steel, manufactured by Branson Instruments, Inc., makes measurements "rapidly, without damage to the coating and the thickness is indicated directly on the meter of the instrument." The Coatingage head contains a coil, connected to a bridge circuit. Coating thickness is measured

The Record Of Progressive Technical Achievement

IT'S 4 in 1 AT SILSBEE



The new Silsbee (Texas Gulf Coast) plant of American Republics Corporation is an interesting example of the flexibility available in modern gasoline plant design. Field operations provide four separate gas sources which enter the system under extreme variation in pressures. Flare gas is received at 150 to 300 lbs., Gas-lift gas at 600 lbs., Pipe Line Sales gas at 900 lbs., and Cycling gas at 2200 lbs. The combined input is processed in a compact, flexible system designed to handle 75 million cubic feet daily with high extraction efficiency of propane in addition to butane, LPG, leaded and unleaded motor fuel, kerosene and absorption oil. Silsbee is typical of the many distinctive gas processing plants designed and built by Gasoline Plant Construction Corporation in the Gulf Coast area, where we hold an enviable record for outstanding achievement in modern hydrocarbon processing.

GASOLINE PLANT CONSTRUCTION CORP.

ENGINEERS . . . DESIGNERS . . . CONSTRUCTORS

NIELS ESPERSON BLDG., HOUSTON

NIXON BLDG., CORPUS CHRISTI

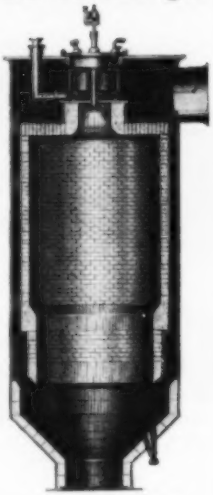
for peak efficiency

on high-pressure furnaces

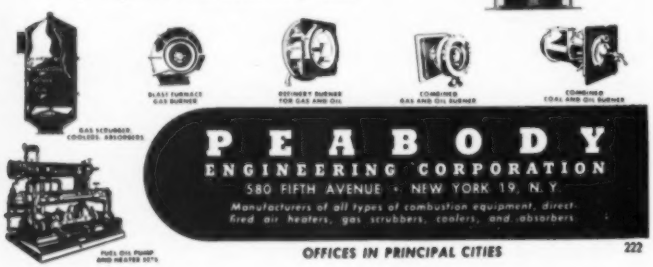
with sustained loadings

PEABODY Direct Fired Air Heater and Burner Units are in service throughout the petroleum industry in every part of the world. Proof that these Peabody units operate to our client's entire satisfaction in various refinery operations is evidenced by the many duplicate installations that we've made for these same clients.

Peabody designs and builds Direct Fired Air Heater and Burner units for operating pressures ranging from atmospheric to 125 lbs. psia and outlet temperatures ranging up to 1800° with firing rates to 100,000,000 BTU per hour. *Specific performance and engineering proposals on request. No obligation.*

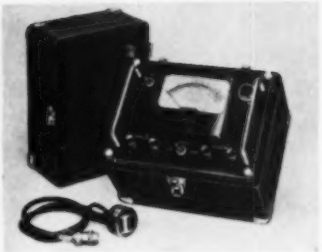


HIGH-PRESSURE BURNERS—specially constructed for firing high-pressure furnaces to give dependable performance with special emphasis on stable operation at all times. These burners are designed to burn either gaseous or liquid fuels or both fuels in combination. Wide flexibility permits regulation by simplified central control system.



PEABODY
ENGINEERING CORPORATION
580 FIFTH AVENUE • NEW YORK 19, N. Y.
Manufacturers of all types of combustion equipment, direct-fired air heaters, gas scrubbers, coolers, and absorbers

OFFICES IN PRINCIPAL CITIES 222



by the effect of changes in the reluctance of the magnetic circuit. Two concentric scales cover a range of 0.0001-0.50 inches. Power is supplied by two 67½-volt batteries and one 1½-volt battery, contained in the instrument.

For further information write Branson Instruments, Inc., 436 Fairfield Avenue, Stamford, Conn., referring to PETROLEUM REFINER item **225.**

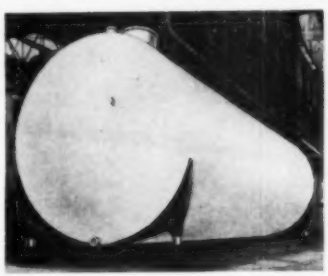
Pyrometers, Waste Disposal

The Bristol Company's bulletin 138 describes the application of the company's automatic pH recording and controlling instruments and recording flow meters to industrial waste disposal operations. Diagrams of several typical waste disposal applications are included.

The same company's bulletin P1239 on diesel engine pyrometers describes approved Navy and commercial type diesel engine pyrometers and thermocouples suitable for use on all types of diesel engines. Dimensional drawings are included.

For a copy of either bulletin write The Bristol Company, Waterbury 91, Conn., referring to PETROLEUM REFINER item **226.**

Chemical Storage Tank



The Pfaudler Company is producing a one-piece, glass-lined chemical storage tank in sizes up to 35,000 gallons capacity. Measuring 12 feet in diameter by 45 feet long, the new tank is claimed to be fully resistant to all acids at all concentrations except hydrofluoric and concentrated phosphoric acid.

For further information write The Pfaudler Company, 1000 West Avenue, Rochester 3, N. Y., referring to PETROLEUM REFINER item **227.**

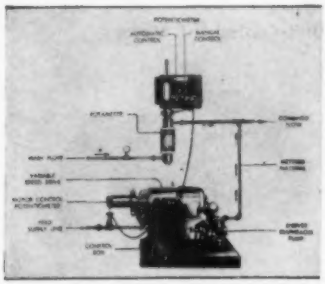
Steel Strainers

Edward Valves, Inc., has issued Bulletin 712 providing information on forged steel strainers. The strainers have an ASA rating of 600 pounds at 850° F. for steam, oil or vapor and a hydraulic

rating of 1440 pounds at 100° F. Dimensions and weights, correct installation, maintenance and cleaning are also discussed in the bulletin.

For a copy write Edward Valves, Inc., East Chicago, Ind., referring to PETROLEUM REFINER item **228.**

Proportional Feeder



T. Shriver & Company, Inc., has developed a new proportional feeder designed to provide "a constantly proportioned feed of any corrosive, abrasive, viscous thick, difficult or valuable materials which could not be handled by ordinary proportional feeders." Additional features to the standard feeder are recording devices, totalizers and an automatic cut-off device. There "are no stuffing boxes or glands in the pump, sensitivity may be controlled and feed rates are proportional or constant." Motors are of standard a.c. type and the feeder capacities range from 1½ to 90 gpm. Pressures go up to 100 psi.

For a copy of Bulletin 129 write T. Shriver & Company, Inc., 810 Hamilton Street, Harrison, N. J., referring to PETROLEUM REFINER item **229.**

Portable Hoist

Lug-All, new portable hoist developed by Lincoln Precision Machining Company, has a power ratio of 30 to 1 and a total lift of 90 inches. The 20-inch lever will begin to bend before any part approaches its breaking point and the cable is non-kinking and is shielded to prevent backlash, according to the company. Constructed of aluminum alloy, the hoist weighs 8½ pounds and handles loads up to 1½ tons. No special tools are needed to repair parts damaged or broken and the repairs can be made on the spot. Lug-All has a one year guarantee against mechanical failures.

For further information write Lincoln Precision Machining Company, North Grafton, Mass., referring to PETROLEUM REFINER item **230.**

Hardfacing

A reprint, "The Economies of Hardfacing," available from Air Reduction Sales Company was written by J. J. Barry and Albert Muller. Illustrated

Fig. 2140
GLOBE
125 lb. S.P.
200 lb. W.O.G.

125 lb. S. P. BRONZE GLOBE, ANGLE and CHECK VALVES
Built to **LUNKENHEIMER**
QUALITY STANDARDS

Want a lower pressure valve to give the same dependable, low-cost service you get in higher pressure LUNKENHEIMER Valves?

Here it is — New Fig. 2140 Globe; Fig. 2141 Angle; Fig. 2142 Lift Check; Fig. 2144 Swing Check. These valves feature Lunkenheimer's traditionally fine design and sturdy construction, plus exclusive silicon bronze alloy stems which eliminate stem thread failure due to wear.

Whatever your requirements for lower pressure service, you'll find these new valves unequalled for dependability and true economy.

Your LUNKENHEIMER DISTRIBUTOR is stocking these new 125 lb. S.P. Bronze Valves. Call upon him for your original equipment, replacement and repair valve requirements. Ask him for Circular No. 582 or write direct.

ESTABLISHED 1862
THE LUNKENHEIMER CO.
—"QUALITY"—
CINCINNATI 14, OHIO, U. S. A.
NEW YORK 13 CHICAGO 6
BOSTON 10 PHILADELPHIA 34
EXPORT DEPT. 318-322 HUDSON ST. NEW YORK 13, N. Y.

Fig. 2142 LIFT CHECK
125 lb. S.P. 200 lb. W.O.G.

Nowhere in the line is dependability more important than in Check Valves. These Checks function quickly and positively, seat accurately and tightly.

Fig. 2144 SWING CHECK
125 lb. S.P. 200 lb. W.O.G.

Here's why Petroleum Refiner is wanted by so many refinery men—

THOROUGH coverage of current technical and economic thought in the field of petroleum refining, natural gasoline and petrochemical manufacturing.

PRACTICAL articles written by outstanding authorities of the industry.

"SHORT CUTS" published under the heading of "How To Do It" which bring you practical suggestions which have already made and saved money for other companies.

DETAILED data on new processes and improvements on old ones.

INFORMATION on practical as well as theoretical phases of process plant design and operation.

A REVIEW of technical literature on refining, natural gasoline and petrochemical manufacturing making quickly available the source of additional data on a subject of particular interest.

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Company_____

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with 14 photographs, the article reviews the advantages of hardfacing and offers an analysis of the problems leading to the correct selection of the proper hardfacing rods. Design and cost figures are offered, plus a selected bibliography.

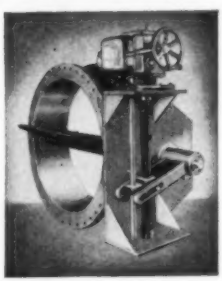
For a copy write Air Reduction Sales Company, 60 East 42nd Street, New York 17, referring to PETROLEUM REFINER item **231.**

Unit-Cooled D-C Motors

General Electric standard totally-enclosed, unit-cooled d-c motors in ratings up to 200 hp. are available with a new type cooling assembly. Two blowers, driven by a single GE tri-clad induction motor provide ventilation independent of motor speed. The new cooling system makes "full torque possible down to almost zero speed continuously." The unit cooler is built of pressed-steel sheets stacked and welded to provide alternate air passages at right angles to each other. Upon entering the cooler, clean air from the motor is broken up into small streams by multiple passages which are surounded by similar streams of cool air coming from the outside. Motor air never comes into contact with the contaminated outside air. The motors "require no piping, duct-work air filters or pressurized air supply."

For a copy of Bulletin GEA-4469A write General Electric Company, Schenectady 5, N. Y., referring to PETROLEUM REFINER item **232.**

Hydraulic Service Valve



R-S Products Corporation has developed a 54-inch iron valve for hydraulic service and for controlling the flow of

condenser water. This valve has 125-pound American Standard flanges and is operated by a limitorque electric motor connected to a threaded reach rod that moves the valve slowly to prevent water hammer. Threads on the reach rod can be cut for speeds ranging from 60 seconds up to eight minutes. The valve can be fitted with a renewable and replaceable rubber spool for positive 100 percent shut-off, providing bubble-tight shut-off up to 80 psi. air and commercially tight shut-off up to 100 psi. water.

For further information write R-S Products Corporation, Wayne Junction, Philadelphia 44, referring to PETROLEUM REFINER item **233.**

Discharge Check Valve

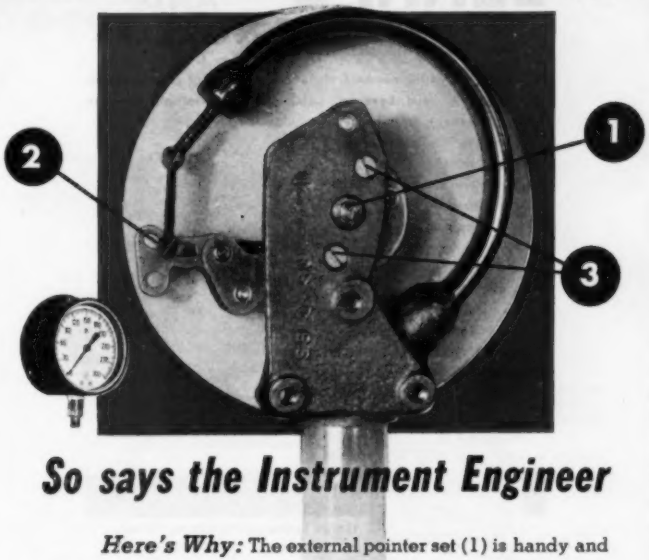
A discharge check valve, designed by J. A. Zurn Manufacturing Company, is claimed to minimize fouling because the units have a swing check flap suspended from a full floating pin fulcrum, assuring positive full surface contact between ground face of flap and flap seat. The knob in the center of the top surface of the swing check flap contacts the valve body roof at only one point when the flap is wide open to assure free operation. The valves may be operated with or without a manual control as well as with an extension shaft or a flexible cable from an access box. Flanges are 150 pounds flat faced and are available with 180, 105 or 90 degree bodies made of cast bronze, steel, semi-steel, cast iron and alloy metals for corrosion resistance.

For further information write Department Z-8, J. A. Zurn Manufacturing Company, Erie, Pa., referring to PETROLEUM REFINER item **234.**

Torches

Weldit, Inc., has introduced a new series of torches designed to use atmospheric air and either propane or acetylene. Torch C-48 has full Weldimatic trigger control, adjustable pilot light and needle valve adjustment. Torch C-48W is identical without the Weldimatic feature. Torch B-49 is a single tube lightweight torch with needle valve adjustment for acetylene and atmospheric air. Torch C-48B is a standard C-48 torch

EASIEST GAGE TO CALIBRATE

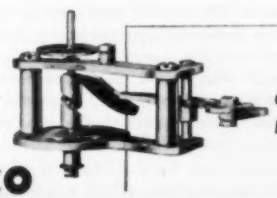


So says the Instrument Engineer

Here's Why: The external pointer set (1) is handy and very useful. In no other gage can the pointer be set without removing the glass and ring. Often a HELICOID gage can be made accurate simply by resetting the pointer.

If recalibration is necessary, the complete gage system is removed from the case. But there is no need to remove the pointer or dial. All adjustments are conveniently at the rear. For pointer travel, the link screw (2) is moved inward or outward in the cam slot. For scale linearity the movement is rotated by loosening screws (3). All this can be done *quickly* with a Helicoid gage. When recalibrating other gages, the pointer and dial must be removed frequently until calibration is attained. This takes more time and costs money.

The HELICOID gage is the easiest to calibrate and the easiest to keep in calibration.



Only Helicoid Pressure Gages have the Helicoid Movement

ACCO

HELICOID GAGE DIVISION
AMERICAN CHAIN & CABLE
Bridgeport 2, Connecticut

TRADE MARK

LENAPE MANWAY NECKS AND NOZZLES

TYPE SR

● In ever increasing numbers, designers and users of process vessels in many fields—food, beverage, paint, pharmaceutical, oil, etc.—are turning to Lenape for preferred variations in standard manway necks and nozzles.

Construction employs standard Type R Necks or Nozzles with covers, hinge or davit, and toggle bolts.

Special bronze trim for marine use, babbit joint for spark proof service, view or sample ports, etc. are provided when specified.

Send for special Bulletin 4-82, price schedule M48B and pending complete new catalog 9-49.

Top Unit: Standard SR Neck with Quick-opening sample port. Lower Unit: SR Neck frame only, with toggle bolts and special hinge for flame barrier screen lid installed by purchaser.

LENAPE HYDRAULIC PRESSING AND FORGING CO.

LENAPE HYDRAULIC PRESSING & FORGING CO.
DEPT. 106 WEST CHESTER, PA.

WATER INTAKE SCREENS

TO YOUR SPECIFICATIONS

The illustration is typical of Multi-Metal application used by a petroleum processor where emphasis is on rugged and accurately aligned construction. Note how the heavy wire mesh is carefully welded to the heavy angle iron frame. Such attention to even the slightest details of workmanship is a 35-year old tradition at Multi-Metal. We custom fabricate your choice of wire or filter cloth to any desired type of unit, from a small strainer to the most complex filtering apparatus. Send blueprints for a quotation, or write for free catalog and wire cloth samples.

Wire Cloth
Filter Cloth
All Meshes
All Metals

Wire Cloth in Fabricated Units, or by the Roll and the Cut Piece.

Multi-Metal
WIRE CLOTH COMPANY, INC.
1350 Garrison Ave., New York 59, N. Y.

with heavy duty extension and special burner for use with light portable tanks in removing paint from wood or metal surfaces.

For further information write Weldit, Inc., 990 Oakman Boulevard, Detroit 6, Mich., referring to PETROLEUM REFINER item **235.**

Air Impact Wrench

A new air impact wrench, designed by Ingersoll-Rand Company to handle large studs, bolts, nuts and cap screws from 1¼ to 2-inch thread size, operates on the rotary impact principle, by which motor torque is converted into 1000 rotary impact blows per minute. Free speed is 535 to 565 rpm.

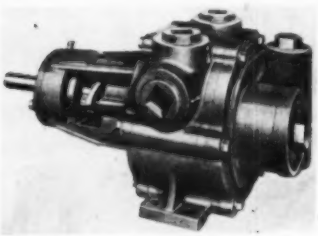
For further information write Ingersoll-Rand Company, 11 Broadway, New York, referring to PETROLEUM REFINER item **236.**

Corrosion Tests

A report on corrosion tests in organic sulfation and sulfonations has been issued by The International Nickel Company, Inc. Based on study of the behavior of different metals and alloys, the report contains 15 tables.

For a copy write The International Nickel Company, Inc., 67 Wall Street, New York 5, referring to PETROLEUM REFINER item **237.**

Heavy Duty Pumps



A heavy duty Tri-Rotor pump for handling non-lubricating materials, designed by The Yale & Towne Manufacturing Company, is applicable for handling materials at differential pressures of 50 psi. or less. It may be equipped with solid, by-pass or variable volume control type heads. All heads are interchangeable. The new models are equipped with a Timken double roller combination radial and thrust bearing, which is integral with the shaft housing. A special alloy shuttle complete with

carbon bushing is used when handling clean, non-lubricating materials. A large carbon bushing, located in the shaft housing is designed to carry the radial load of the rotor assembly as well as the operating pressures. The pump is available in 2, 2½ and 3-inch sizes.

For further information write The Yale & Towne Manufacturing Company, Chrysler Building, New York 17, referring to PETROLEUM REFINER item **238.**

Safety Cage

A new aluminum alloy roll-around safety cage for tank painting, cleaning, inspection and general maintenance work is being manufactured by Up-Right Scaffolds. The "roll-around" proper weighs 25 pounds. A wire cable is fastened to an eye-bolt in the center of the top of the tank, threaded through the curved tube of the roll-around and fastened to a block-and-tackle or electric hoist. One set of casters of the roll-around rolls on the top of the tank next to the rim. These casters can be locked whenever desired, to prevent rolling. The bracket on which the other set of casters is mounted is adjustable up and down vertically so as to permit these casters to roll on the rim of the tank. A safety-cage, weighing 70 pounds, replaces the old bosun's chair. The safety-cage is raised, with the operator, to the height desired. The operator's safety belt is fastened to the rear guard rail. An arched support construction permits free movement of pole guns and other tools from side to side. The casters are set to roll vertically as the cage is being raised and horizontally as the cage and roll-around are rolled around the periphery of the tank by an operator on the top of the tank.

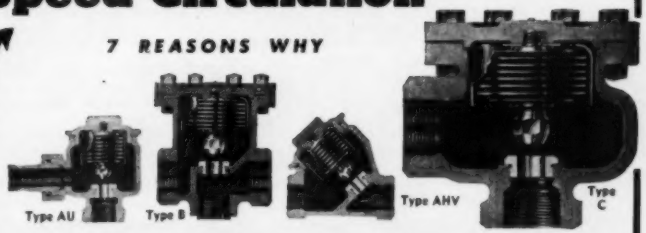
For further information write Up-Right Scaffolds, 1013 Pardee Street, Berkeley, Calif., referring to PETROLEUM REFINER item **239.**

Liquid Level Transmitters

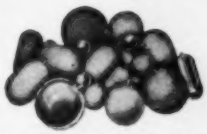
Taylor Instrument Companies has announced Bulletin 98069 describing liquid level transmitters specifically designed to measure pressure and liquid level of viscous or corrosive liquids and liquids containing solids and adaptable to open tanks as well as closed tanks under pres-

Nicholson Steam Traps Speed Circulation

7 REASONS WHY



1. **BIG DISCHARGE, 2 to 6 times average traps.**
2. **NO AIR-BINDING. Discharge both air and water.**
3. **NO FREEZE-UPS. Drain completely when cold.**
4. **NO DRIBBLING. Close tight when steam is in trap.**
5. **NO ADJUSTMENT needed for varying pressures.**
6. **NO WATER LOGGING. Operate on lowest temperature differential, 5° to 15°, depending on trap size and steam pressure.**
7. **LOWEST STEAM WASTE. As little as 1%.**



HIGH-PRESSURE FLOATS — Stainless, monel, steel or plated steel. Welded. In all sizes and shapes; for operating mechanisms and as tanks or vessels. 2-day delivery. **BULLETIN 348.**

5 TYPES for every application. Sizes ¼" to 2"; press. to 225 lbs. BULLETIN 1047.

W. H. NICHOLSON & CO.
207 OREGON ST., WILKES-BARRE, PA.

now ready
new ideal..

Bulletin No. 68

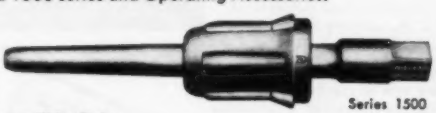
Developed in condensed, easy-to-read form, with Specification tables for selecting the *Correct Tube Expander* to meet your particular need.

Series 900

Ideal Rolling and Flaring Tube Expanders

The new 900 series for Superheater and Small Tubes.

Also improved 1500 series and Operating Accessories.



Series 1500

See Your Dealer, or Write Today.
Ask for BULLETIN 68.

The Gustav Wiedeke Company
DAYTON 1, OHIO

sure or vacuum. Explained is the transmitters force-balance principle of operation with a diagram to point out its corrosion resistant construction design. Application drawings show its adaptability to different types of installations and for flow measurement service with graphs illustrating the instrument's responsive performance.

For a copy write Taylor Instrument Companies, 95 Ames Street, Rochester 1, N. Y., referring to PETROLEUM REFINER item **240.**

Engineering Developments

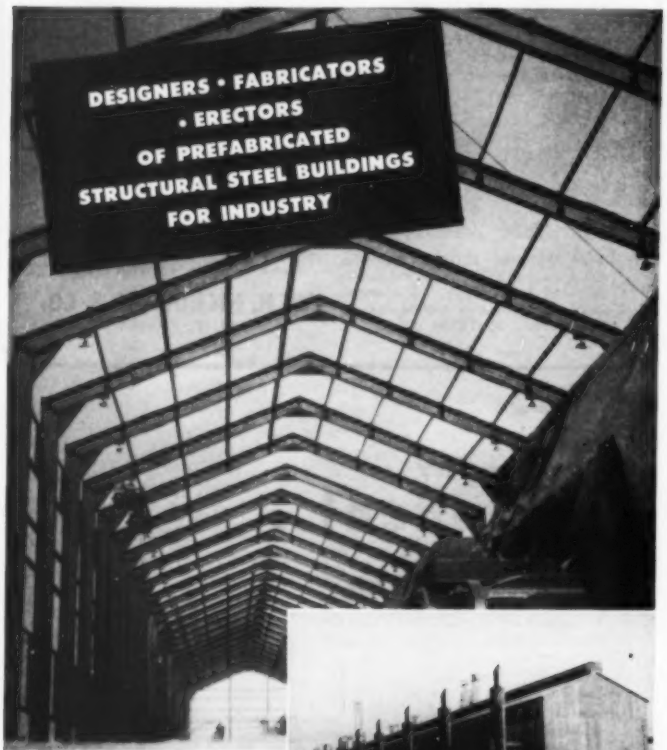
Allis-Chalmers has released its 1948 annual review of the company's engineering developments. Divisions of industry included in the review are power generation, power distribution, metals, coal, rock products, petroleum, construction and public works, forest products, farming, food, general industrial and research.

For a copy write Allis-Chalmers Manufacturing Company, P. O. Box 512, Milwaukee 1, Wis., referring to PETROLEUM REFINER item **241.**

Refractory

Walsh H & B castable, new mix-and-pour refractory, is described in a new bulletin issued by Walsh Refractories Corporation.

For a copy write Walsh Refractories Corporation, Department C, 4070 North First Street, St. Louis 7, Mo., referring to PETROLEUM REFINER item **242.**



Metallic shop-welded, fieldbolted buildings are furnished with rigid bent and truss (peak or bowstring) structural steel frames with optional wall and roof covering of corrugated steel or asbestos.

They are offered in a wide range of standard sizes or can be designed to your specifications and special requirements.

Metallic erection crews are available anywhere in the Southwest. They know your problems in the oil and gas industry. They know what service really means.

METALLIC
BUILDING COMPANY
HOUSTON, TEXAS
4601 HOLMES ROAD

Adjustable Wrenches

J. H. Williams & Company has added a new line of carbon steel adjustable wrenches which are "thinner and lighter than conventional carbon steel adjustable wrenches of similar capacity." Made in 4, 6, 8, 10, 12, 15 and 18-inch sizes with maximum capacities from ½ to 2 1/16 inches, these new wrenches have Williams' patented sliding jaw feature. The design of the square shoulders on the shank portion of the sliding jaw "provides maximum and positive bearing against working stress with wedging and spreading action eliminated."

For a copy of booklet A-40 write J. H. Williams & Company, 400 Vulcan Street, Buffalo 7, N. Y. referring to PETROLEUM REFINER item **243.**

Fish Tape

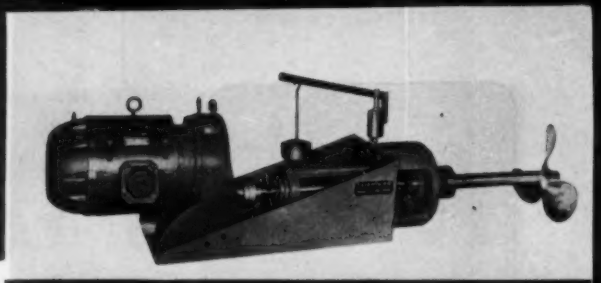
Coil-Flex, the new fish tape of Ideal Industries, Inc., consists of a 25 foot length of steel spring 11/32 inches in diameter with a rustproof inner steel cable. Lengths can be joined together. The tape which can be rolled into a 10-inch diameter circle, "never kinks, snarls or springs loose." It can be used in all types of conduits, including aluminum. Ends are smooth and round and the tape can be pulled "through any and all bends allowed by the electrical code." Pull is tested at 400 pounds.

For further information write Ideal Industries, Inc., 1531 Park Avenue, Sycamore, Ill., referring to PETROLEUM REFINER item **244.**

Pipe Markers

Self-adhesive Quik-Label pipe markers, announced by W. H. Brady Company, conform to ASA Standard A13. The markers are printed with the names of the materials carried in the pipes in large black letters on the correct ASA background colors. It is claimed the labels can be read up to 75 feet in flashlight illumination. Weather and water-proof, the labels are on a card equipped with a starter-strip which auto-

SAVE 3 WAYS
WITH
LIGHTNIN & MIXCO
MIXERS



INITIAL COST

Before you buy any mixer, check the quotation to make sure you know what you are getting for the quoted price.

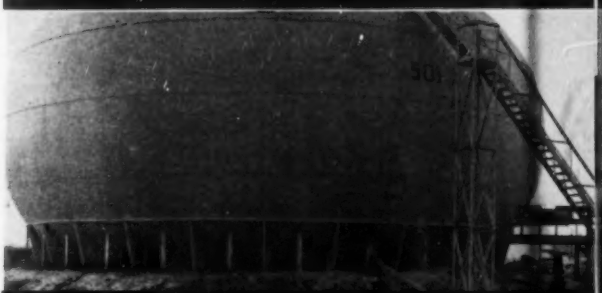
With a Lightnin & Mixco Mixer you get all that you pay for—a complete unit. Simply bolt it onto your tank and turn on the power.

And, low maintenance costs are assured because in the simple, sound design you get:

1. Proper stuffing box performance.
2. Shafts mounted in adequate bearing supports.
3. Shut-off device which enables repacking with full or partially full tank.

That's why Refineries standardize on Lightnin and Mixco Mixers.

INSTALLATION



OPERATION

Designed for
Preferred for
Proved in
REFINERY SERVICE

PROCESS ADAPTED AGITATION

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LIGHTNIN MIXCO

"LIGHTNIN"— SIDE ENTERING MIXERS SPECIFIED FOR . . .

1. Gasoline Blending
2. Fuel Oil Blending
3. Lube Oil Blending
4. Blending Charging Stocks
5. Asphalt Cutback Blending
6. Specialties Mixing
7. Mud Mixing

Mixco Units specified for the following, either batch or continuous operations:

1. Treating
2. Heat Exchange Improvement
3. Suspensions
4. Liquid Gas Contacting
5. Reaction Control

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MIXING EQUIPMENT CO., Inc.

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MIXING EQUIPMENT CO., INC.,
1064 GARSON AVE., ROCHESTER 9, N. Y.
Please send me the literature checked:

- ☐ B-66 & B-76 Side Entering Mixers
- ☐ B-75 Portable Mixers
- ☐ B-78 Top Entering Mixers
- ☐ B-77 Laboratory Mixers
- ☐ Complete Refinery Catalog Binder

Name .....
Title .....
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LIGHTNIN & MIXCO MIXERS ARE COMPLETE . . . READY TO OPERATE WHEN DELIVERED

Jergison Reflex Gage

They keep you out of trouble . . . and Save You Money

You get a lot of plus values . . . and avoid a lot of failure headaches and possible accidents . . . by using Jerguson Flat Glass Gages for every liquid level indicating use.

You get the kind of gages and valves you want to do YOUR JOB. Jerguson offers you the most complete line available. Jerguson offers you an engineering organization specializing in building special gages to meet problems.

Jerguson Flat Glass Gages save money and labor. They are easy to install. They stand up . . . you don't have to keep servicing them or replacing the glass. They are available in a wide range of sizes, pressures, designs and materials; also with polished end stems to replace present tubular gages.

Write us about your problems or requirements.

JERGUSON
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100 Railway, Somerville 45, Mass.
Representatives in Major Cities
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matically releases part of the label for application. A new company folder lists more than 150 stock pipe markers. In addition 23 conduit markers printed with all standard NEMA voltages from 110V through 4800V are listed.

For a copy of the folder write W. H. Brady Company, Department 156, 815 North Third Street, Milwaukee 3, Wis., referring to PETROLEUM REFINER item **245.**

Continuous Drainer

Bulletin CD-100, issued by Industrol Corporation, describes its continuous drainer which consists of a tank in which the level is maintained by a pneumatically operated displacement type level controller actuating a diphragm motor valve. Standard sizes are available for the removal of from 4500 to 82,000 pounds per hour of condensate. Designed to ASME Code, Par. U-69 for 150, 300 and 600 psig, the drainer has a diphragm motor valve which is actuated to supply high pressure steam to force the condensate to the condensate system.

For a copy of the bulletin write Industrol Corporation, 88-35 76th Avenue, Glendale, Brooklyn 27, N. Y., referring to PETROLEUM REFINER item **246.**

Roofing Sheet

To help the architect, engineer and contractor prevent roof failures caused by unusual climatic conditions or atmospheric concentrations of smoke, fumes and other corrosives, The International Nickel Company, Inc., has issued a bulletin which lists suggested gauges for principal exterior building applications of soft-temper Monel roofing sheet. Relative cost of Monel roofing sheet is included as are fabricating and istallation tips and a specification wording for use by architects and engineers.

For a copy write The International Nickel Company, Inc., 67 Wall Street, New York 5, referring to PETROLEUM REFINER item **247.**

Metal Hose

Chicago Metal Hose Corporation has isued Catalog G-50 containing description and specifications for standard types of flexible metal hose in a variety of metals. In addition there are expansion joints for piping systems, stainless steel and brass bellows and various conduits and special assemblies of these components.

For a copy of the catalog write to Chicago Metal Hose Corporation, Maywood, Ill., referring to PETROLEUM REFINER item **248.**

Scientific Equipment

Advances and developments in the scientific field are presented in "Announcer," a new publication of Burrell Technical Supply Company. Fluted funnels, binocular wide field microscopes, vacuum pressure regulator, instrumount, water aerator, parafilm, immersion heaters, electric vacuum oven and additional items are discussed.

For a copy write on business letterhead to Burrell Technical Supply Company, 1942 Fifth Avenue, Pittsburgh 19, referring to PETROLEUM REFINER item **249.**

Induction Motors

Elliott Company has released Bulletin PB 7000-1 on its new two-pole, 250-3500 hp, Fabri-steel induction motors. These motors may be of the drip-

Problem:
to cut down on pump failures in moving fluids.

Solution:
Specify long-life, dependable pumps by *Eastern*

Built to stand the gaff of long, multiple-cycle non-lubricating liquid pumping, Eastern GW Series Pumps operate efficiently and economically. They're quiet, consume little power and deliver uniform performance day in and day out.

The Eastern GW Series is precision-built in two sizes: GW-1, rated at ½ G.P.M. and GW-2, rated at 1 G.P.M. — against pressures up to 200 P.S.I. — plenty of pumping power and volume for normal liquid transfer applications.

CHECK THESE FEATURES

Stainless steel drive gear; graphite carbon composition driven gear; no metal-to-metal contact; graphite impregnated bearing; hydraulically balanced; lifetime stuffing box mechanical seal; tough bronze construction.

You can get immediate deliveries on both Eastern GW Series Pumps. They are supplied with 1/6 or 1/4 H.P. motors; belt driven or flexible coupling driven units are also available.

WRITE FOR FULL DETAILS

Eastern
INDUSTRIES, INC.
308 Elm Street
NEW HAVEN 6, CONN.

PETRO-CHEM ISO-FLOW
CATALYTIC REACTOR
FURNACES WITH . . .
CATALYST IN TUBES
PETRO-CHEM
ISO-FLOW FURNACES

HARPER

NON-FERROUS AND STAINLESS STEEL Everlasting Fastenings OFFER

13 Reasons

FOR USE IN YOUR PRODUCT over common steel...

1 Resistance to Rust and Corrosion
2 Resistance to High Temperatures
3 Non-Magnetic
4 Non-Sparking
5 Re-Usable
6 Attractive Appearance
7 Easy to Clean
8 High Strength
9 Long Life
10 Lower Ultimate Cost
11 Resistance to Fatigue
12 Easy to Plate or Finish
13 Resistance to Abrasion and Wear

OVER 6000 ITEMS IN STOCK

Bolts, Nuts, Screws, Washers, Rivets and Accessories in Brass, Bronzes, Copper, Monel and Stainless Steels.

Write for Catalog giving blue print drawings, dimensions, threads, heads and sizes of each item.

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(Suburb of Chicago)
New York Office and Warehouse
200 Hudson Street, New York 13

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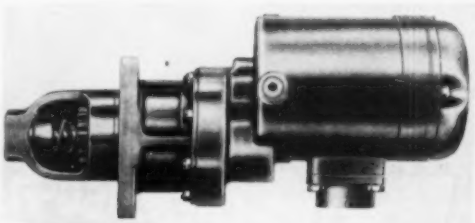
HARPER

proof, splash-proof, enclosed—self or separately-ventilated types. Sleeve bearings are ring-oiled for motors 900 hp and smaller and pressure-lubricated for motors 1000 hp and larger.

For a copy of the bulletin write Elliott Company, Electric Power Department, Ridgway, Pa., referring to PETROLEUM REFINER item **250.**

Air Cranking Motor



Leece-Neville Company's new air cranking motor "designed for quick dependable, low cost starting" of diesel and gasoline engines, is well-adapted to use in the oil fields, where natural gas may be used in its operation in place of compressed air. High-pressure gas is reduced to 125 to 150 pounds pressure and piped right into the motor. Weighing only 43 pounds, the motor occupies no more space than an electric starter, and can be installed with the same three bolts used for mounting the latter. One motor may crank engines up to 1000 cubic inches displacement under normal conditions. Two motors may be used for larger engines.

For further information write Leece-Neville Company, 5363 Hamilton Avenue, Cleveland, Ohio, referring to PETROLEUM REFINER item **251.**

Seatless Piston Valves

In the new Strahman valve, manufactured by Klingerit, Inc., a stainless steel piston sliding into the ring "effects positive closure because of long sealing surface." The ring is also available in materials suitable for hard-to-hold liquids or gases. Easily replaceable, the ring may be further compressed against the piston by a take-up on the bonnet while the valve is in service. The valve is suitable for a low or high temperature range of minus 125° to plus 750° F.

For further information write Klingerit, Inc., 20 Hudson Street, New York 13, referring to PETROLEUM REFINER **item. 252.**

Piping Materials

Crane Company's Circular 320 on corrosion-resistant piping materials, offers information on the complete Crane line of valves, fittings, fabricated piping and pipe coils to meet a wide range of corrosive conditions. Included also are condensed recommendations, description of alloy materials and a corrosion questionnaire.

For a copy write Crane Company, 836 South Michigan Avenue, Chicago 5, referring to PETROLEUM REFINER item **253.**

Universal Tester

Four individual ranges permit the operator of the multi-low-range universal tester, manufactured by W. C. Dillon & Company, Inc., to obtain close readings on its 8-inch dial. The scale is available in ounces, tenths pound or kilos, four divisions each, with scale in different colors. Bulletin M describes the operation of the tester, which will "accurately test any material light enough to fall within the range of its four scales."

For a copy of the bulletin write W. C. Dillon & Company, Inc., 5410 West Harrison Street, Chicago 44, referring to PETROLEUM REFINER item **254.**

Contour Cutter

Heath Engineering Company employs a standard acetylene machine cutting blowpipe on its contour cutter to automatically reproduce a pattern in any sheet steel or heavy plate steel. Master patterns "can be quickly changed, and working edges are clean, smooth-fitting and ready for welding." The brain or pattern-tracing finger, incorporates a variable speed, magnetic rotor with a diameter of ¼ inch. Optional operating speed permits "adjustment to accommodate any gage steel or production procedure." Pattern sizes include ¾-inch holes to five-foot diameter shapes. All

ESPECIALLY RECOMMENDED FOR USE IN THE

COPPER SWEETENING PROCESS

Nichols

TRIANGLE BRAND

COPPER SULPHATE

is preferred by leading refineries because of its high copper content, dependable uniformity and exceptional purity and freedom from foreign and inert matter.

99% + PURE

Quotations on request, on any quantity required. Shipments can be made from our nearest plant.

PHELPS DODGE REFINING CORP.
40 WALL STREET, NEW YORK
230 N. MICH. AVE., CHICAGO

1. The pipe has first been thoroughly cleaned. Here Armstrong's Waterproof Cement is being applied.

2. Sections of cork covering are tightly butted against each other. Longitudinal joints at top and bottom.

3. The covering must hug the line snugly. It is held in place with copper-clad steel wire, drawn tight.

How to get a good cold line insulation job

The combination of good material and workmen who know how to apply it properly is your best assurance of long and efficient performance from cold line insulation. Workmanship is extremely important, for poorly applied insulation means needless waste of expensive refrigeration. The slightest opening in any joint allows heat to flow in and moisture to condense in the break. If this moisture freezes it exerts a pressure that enlarges the opening and may damage the insulation itself.

Shown here are five of the important steps in doing a good cold line insulation job—a job that with proper maintenance will last for many years and keep cost of refrigeration down. The insulation being used is Armstrong's Cork Covering, a material whose low thermal conductivity and general all-around durability have made it the standard of comparison among cold line insulations. It is being applied by one of the skilled workmen of Armstrong's Contract Service.

For an estimate on the cost of insulating a low-temperature line the way it should be done or for full information on Armstrong's Cork Covering, call the Armstrong District Office nearest you or write direct to Armstrong Cork Company, Building Materials Div., 7505 Concord St., Lancaster, Pa.

4. All joints are carefully painted up and sealed with Armstrong's Seam Filler to keep out vapor.

5. The completed job gets a good coat of Armstrong's Cork Covering Paint.

- **DON'T** apply insulation when the line is cold or wet.
- **DON'T** try to save money by using untrained workmen.

ARMSTRONG'S INDUSTRIAL INSULATION

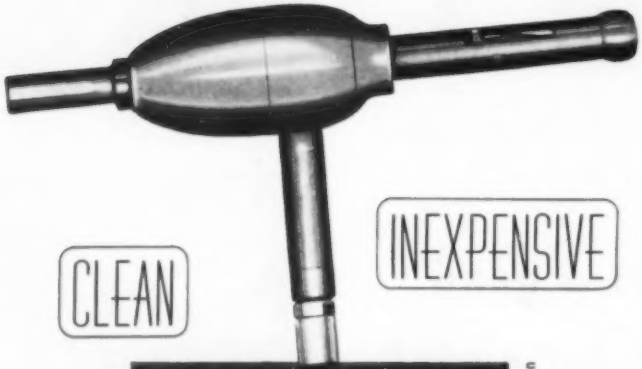
Complete Contract Service For All Temperatures

From 300° Below Zero

To 2800° Fahrenheit

with airetool's
new co-100
TUBE
CUTTING
IS...

FAST



CLEAN

INEXPENSIVE

An Internal Type Condenser Tube Cutter for ferrous, non-ferrous and bi-metal tubes ½" to 1½" O.D. Tube Sheet Thicknesses from ½" to 6".

There's an AIRETOOL tube cleaner and expander for every type of tubular construction

AIRETOOL
MANUFACTURING COMPANY
SPRINGFIELD, OHIO

BRANCH OFFICES: New York, Philadelphia, Chicago, Houston, Baton Rouge, Tulsa

moving parts are sealed, ball-bearing mounted and "require no lubrication." Operation is on either ac. or dc. current.

For further information write Heath Engineering Company, Fort Collins, Colo., referring to PETROLEUM REFINER item **255.**

Drainage Control System

Cochrane Corporation's Bulletin 3250 on high-pressure condensate return systems, in addition to material and operating specifications gives capacity ratings for both standard and high-differential units in the six sizes available, 3, 5, 7½, 10, 15 and 25 hp. based on a maximum of 200 psi. above process pressure. Differential pressures to 200 psi. are listed and capacities for each unit are tabulated after each differential pressure for unit inlet pressures varying from 0-39 psi., 40-99 psi. and for over 100 psi.

For a copy write Cochrane Corporation, 17th Street and Allegheny Avenue, Philadelphia 32, and in Canada, Canadian General Electric Company, Ltd., 212 King Street West, Toronto, Ontario, referring to PETROLEUM REFINER item **256.**

Hydraulic Standards

Reprints of the unabridged Joint Industry Conference Hydraulic Standards for Industrial Equipment is being offered by Miller Motor Company. Standard symbols recommended are illustrated. Also listed is a point-by point comparison with cut-away illustrations showing how Miller hydraulic cylinders meet the standards.

For a copy write Miller Motor Company, 4027 North Kedzie Avenue, Chicago 18, referring to PETROLEUM REFINER item **257.**

Carbon Determinator

A determinator for rapid and accurate determination of carbon in cracking catalyst has been developed by Laboratory Equipment Corporation. Consisting of a modified double Orsat analyzer, a special combustion tube furnace and a precise oxygen flowmeter, the determinator has an accuracy of one percent. Analysis time is about 11-14 minutes, but may be shortened with a slight sacrifice in accuracy. A complete analysis can be made on any sample with any percent of carbon, according to the manufacturer. Operating procedure is described also.

For a copy of the bulletin write Laboratory Equipment Corporation, St. Joseph, Mich., referring to PETROLEUM REFINER item **258.**

Gas Odorant

"Oronit LPG Odorant" has been added by Oronite Chemical Company to its line of gas odorants. It is being offered espically for odorizing liquid petroleum gas. Oronite, together with California Research Corporation and the parent company, Standard Oil Company of California, are "pioneers in the gas odorization field, having developed the first commercially manufactured gas odorant, Calodorant, for the natural gas industry in 1930." Since that time two new odorants have been developed. "Alert," a concentrated odorant for natural gas and the new LPG odorant.

For further information write Oronite Chemical Company, 38 Sansome Street, San Francisco, referring to PETROLEUM REFINER item **259.**

About EQUIPMENT and SERVICE Suppliers

Drake

Beitzel

Pennsylvania Salt Directors Elect Executive Officers

Pennsylvania Salt Manufacturing Company has made official changes as follows:

George B. Beitzel has become president. He joined the company in 1930 and has been executive vice president since January, 1949.

Leonard T. Beale, president for the past 20 years, will continue as chairman of the board of directors.

William P. Drake, formerly assistant vice president of sales has become vice president in charge of sales.

William F. Mitchell, assistant president of manufacturing, succeeds Y. F. Hardcastle as vice president in charge of manufacturing. Hardcastle is retiring from active service but will remain a member of the board of directors.

Fred C. Shanaman, president of Pennsylvania Salt Manufacturing Company of Washington and vice president of the parent company, and Beitzel elected to the board of directors.

B. S. & B. Lists Appointments

Black, Sivalls & Bryson, Inc., has made the following appointments:

Olin L. Medley, a graduate of the University of Oklahoma, to the sales engineering staff at Shreveport, La.

Joe Beggs, former branch manager at McPherson, Kan., transferred to managership of the Ellinwood, Kan. branch.

Winston O. Shook, formerly at the Hays, Kan., branch, promoted to branch manager at McPherson.

M. F. Barnes, formerly at the Ellinwood branch, transferred to the sales division and will be located at the regional offices in Great Bend, Kan.

Charles W. Stevens, formerly at Odessa, Texas, transferred to San Angelo, Texas, as sales representative with headquarters at 2320 West Avenue J.

Hydraulic Testing Laboratory Opened

The new half-million dollar hydraulic testing laboratory of Byron Jackson Company pictured herewith was designed primarily to certify the company's pumps prior to delivery. Compilation of performance figures and accurate background information, however, is now serving as a guide to further research and development in the pump field. The laboratory has been opened to the American Society of Mechanical Engineering as well as professors and classes from engineering schools.

Operating in Los Angeles, the laboratory is said to be the most modern of its kind. The large test area, 150 feet by 60 feet with a 400,000 gallon tank varying in depth from 11 to 33 feet permits flexible scheduling of tests after manufacturing is completed.

The laboratory has a venturi capacity up to 70,000 gpm. and testing horsepower to 3000 hp. Equipment includes three horizontal dynamometers (50, 150 and 400 hp.), two vertical induction dynamometers (100 and 200 hp.) a dynamometer speed regulating system that holds the testing speed constant in the range of plus or minus 0.015 percent, and a 600 hp., 50-cycle synchronous motor-generator. A number of submersible electric motor-pump units provide positive suction head when needed.

AMMONIA
(Refrigeration Grade)

TANK CARS and CYLINDERS

direct service from producing point to user available on contract shipments or spot orders from...

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SPENCER CHEMICAL COMPANY
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15 years without a shutdown because of lubrication! That amazing record of modern steam turbine operation is just one example of how PARAMINS-improved lubricants are constantly setting new performance records for modern industrial machinery.

ENJAY PARAMINS additives are developed...and constantly improved...in America's largest, most modern petroleum laboratories.

Proved PARAMINS mean improved oils and fuels

PARATONE—for improved viscosity index. **PARAFLOW**—for lower stable pour. **PARATAC**—for tacky oils and greases. **PARAPOID**—for E. P. gear oils. **PARANOX**—for oxidation inhibition and detergency. **PARASHEEN**—for better appearance. **PARADYNE**—for improved gasoline.

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® TRADE MARK

ENJAY COMPANY, INC.
15 West 51st Street
New York 19, New York

Big Equipment Shipped

Graver Tank and Manufacturing Company, Inc., recently shipped the section of a fluid catalytic cracking unit shown above from its East Chicago, Ind., plant for installation at Wood River Oil and Refining Company's refinery at Wood River, Ill. Claimed to be the largest assembled piece of equipment ever moved from a plant in the Chicago manufacturing area, the bottom cone of the regenerator measured 19 feet 8 inches inside diameter and extended 20 feet 7 inches above rails. It was necessary to load the section on a special "well-bottom" car before the move could be made. Universal Oil Products Company designed the unit.

Hooker Electrochemical Lists Promotion of Three in Sales

Hooker Electrochemical Company, Niagara Falls, N. Y., has announced three pomotions in its sales department:

S. I. Anderson to assistant to the general sales manager. He will engage in both eastern and western sales activities. With Hooker since 1933, Anderson was Mid-West representative and supervisor before he became assistant Eastern sales manager, his previous position.

T. H. Trimble to eastern sales supervisor. He will be in charge of field sales activities in the area from the eastern Ohio boundary through the Atlantic states. Previously he was a field salesman in New York state, Pennsylvania, and the southeastern seaboard states. Trimble has been with Hooker since 1934.

Neil M. Barber to become sales representative for the area comprising eastern Pennsylvania and southeastern seaboard states. He has been with Hooker since 1941 and has been a representative in New York state and western Pennsylvania since 1946.

Dowell Opens Treating Station

Dowell Incorporated, a subsidiary of The Dow Chemical Company, has opened a new treating station in San Angelo, Texas. Harold D. Wehrley, associated with Dowell since 1937, is station manager. J. R. Mowery is service engineer.

Freeman Forms Own Company

Charles A. Freeman has resigned from A. P. Green Fire Brick Company to form his own company at Canyon City, Colo., the new corporation to acquire clay deposits, buildings and equipment located at Canyon City.

Freeman was general manager of A. P. Green Engineering & Management Company, having been connected with the organization since 1928. During this time he was instrumental in developing the use of Missouri fire clays for blast furnace service.

He received his degree in ceramic engineering from the Missouri School of Mines.

Dr. Harry K. Ihrig Honored

Dr. Harry K. Ihrig, vice president and director of laboratories of Globe Steel Tubes Company, Milwaukee, has received a citation for distinguished service in engineering from the College of Engineering of the University of Wisconsin at Madison.

Nordstrom Adds C. S. Quillen To Sales Engineering Staff

C. S. Quillen has been added to the sales engineering staff of M. J. Harper, district manager of Nordstrom Valve Division of Rockwell Manufacturing Company. He will handle the sales of Nordstrom valves in the metropolitan area of New York City.

Quillen

Graduating from the Drexel Institute of Technology in 1933 with a degree in chemical engineering, he has sold process plant equipment for the past ten years. He is a member of the American Institute of Chemical Engineers, American Chemical Society and New Jersey Society of Professional Engineers.

Petro-Chem Chooses Agent

Flagg, Brackett & Durgin, Inc., 405 Park Square Building, Boston 16, has been appointed to represent Petro-Chem Development Company, New York, throughout New England.

E. A. Bertram Manager of Sales for Brown Fintube

E. A. Bertram has been named manager of sales for Brown Fintube Company, Elyria, Ohio. In his new capacity, he will be in charge of all selling of the company's products in the petroleum and chemical industries through its representatives. He will be located in the general offices in Elyria.

Bertram

A graduate of the University of Illinois, Bertram also received a master of science degree in chemical engineering from the California Institute of Technology. He is a member of the American Institute of Chemical Engineers and the American Society of Mechanical Engineers.

Graham to Be Copper Agent

Ernest E. Graham of E. E. Graham and Company, Houston, has been appointed sales representative for the Copper Alloy Foundry Company, Hillside, N. J., and will service Texas, Oklahoma and Louisiana. After completing

CONTROL

SCALE AND CORROSION

in

Cooling Towers Compressors and Engine Jackets

Recently developed applications of the newer colloids and surface-active agents in Wright Chemicals for the petroleum industry result in *improved* water conditioning—*positive* scale and corrosion control. Wright Chemicals contain 100% soluble, available chemicals—no waste or inert matter—insuring increased operating efficiency and reduced cost.

Wright improved chemicals are the result of intensive study and research by men with years of experience in the development, production, application and control of water-conditioning chemicals.

Wright has no one cure-all to solve all problems. Each receives individual treatment. The Wright field engineer, who will call on you upon request, will obtain all necessary information and samples for examination in the modern Wright laboratory. Analyses are interpreted in view of supplemental information received, and recommendations made in the form of a proposal. Clients are provided with regular laboratory service as a periodic check upon conditions.

There is a Wright Field Engineer near you, anxious to help solve your scale and corrosion problems. No obligation.

Send for new Bulletin giving full information on Wright chemicals and their applications.

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Specializing in Water Conditioning

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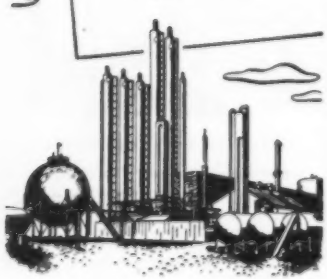
PENNSALT
Anhydrous Ferric Chloride

Catalyst in oil refining and organic reactions

Anhydrous Ferric Chloride is a water-free form containing 95.5%—98% $FeCl_3$ by weight. It is manufactured in this country exclusively by Pennsalt. Pennsalt Anhydrous Ferric Chloride possesses unique solubility in a wide range of organic solvents. This property makes it valuable as a catalyst in *condensation, polymerization* and *chlorination* reactions.

Properties:
Appearance—*fine, greenish-black crystals.*
Melting point—*Approx. 580° F.*
Boiling point—*Approx. 600° F.*
Bulk Density—*Approx. 85 pounds per cu. ft. as packaged.*
Solubility in water—*74.4 grams per 100 ml. at 32° F. 535.7 grams per 100 ml. at 212° F.*
Soluble in *alcohol, acetone, ethers, pyridine, ethyl acetate, nitroethane, ethyl bromide and others.*
Other uses of Pennsalt Anhydrous Ferric Chloride: manufacture of iron salts, paint pigments, ceramics; condensing reagent in making intermediates; conditioning sewage sludge. For further information write:
Heavy Chemicals Division
Pennsylvania Salt Mfg. Company
Philadelphia 7, Pa.

PENN SALT
chemicals



his studies at the University of Texas, Graham spent 14 years with Reed Roller Bit Company before opening his representative offices. He is a member of the American Society for Metals.

T. P. Stone and M. J. Cook Join Wolverine Tube Division

Stone

Cook

T. P. Stone and M. J. Cook have joined Wolverine Tube Division of Calumet and Helac Consolidated Copper Company as salesmen. Their territory includes Florida, Alabama, Georgia, Mississippi, Tennesee, North Carolina and South Carolina.

Formerly a sales representative for Linde Air Products Company, Stone will temporarily headquarter in Atlantic Beach, Fla. Cook was recently affiliated with Orgill Brothers. For the next few months he will be at Jackson, Miss., after which he will headquarter in Atlanta, Ga.

Kerotest Names Chicago Agent

Kenneth F. Vilsack has been appointed Chicago district sales representative of Kerotest Manufacturing Company. He will engage in the sale of oil field, refinery, chemical processing and general industrial steel valves produced by Kerotest. He was previously connected with the Pittsburgh general sales office.

John Koch New Conoflow General Sales Manager

John C. Koch has been appointed general sales manager of Conoflow Corporation, Philadelphia. His headquarters will be at the company's main offices in Philadelphia.

Koch

Attending Rensselaer Polytechnic Institute, Koch entered the industrial control field in 1935 with one of the major instrument companies. In the past ten years he has been active in sales engineering work in the process industries specializing in the application of pneumatic control equipment. In 1945 he joined Conoflow, continuing in a similar line of work.

France Companies Merge

France Packing Company and France Manufacturing Company, both of Philadelphia, have merged, becoming France Packing Company. Main plant and offices will continue to be at 6512 State Road, Philadelphia 35. President of the new company is E. A. France. Both plants are to continue in operation.

Fisher Governor Names Agent For San Francisco District

Fisher Governor Company, Marshalltown, Iowa, has appointed George R. Friederich & Company as its district sales representative in the San Francisco area, replacing the former representative, Swett-Stone Corporation.

George Friederich, head of the new sales office, has been associated with

PAINTS OVER RUST!
RUSTREM STOPS RUST!
No priming, scraping, brushing

Rustrem paints right over rust. For stacks, fire escapes, bridges, fences, flashings... all metal. Farm, auto, marine, machinery. Black and aluminum.

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Paddock CHLORINATORS

Operates on high vacuum . . . no moving parts. 8 capacity ranges — 15 lbs. to 2000 lbs. of chlorine per 24 hours. Also ideal for chlorinating drinking water.

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Sales Agent for Paddock Engineering Company of Texas
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Immediate Shipment

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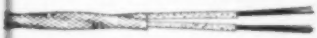
There are two good reasons why we stress Gordon Quality and Gordon Service. (1) The precision quality of Gordon Thermocouple Extension Lead Wire is based upon 32 years of experience in careful selection and inspection to meet rigid insulation requirements. (2) Gordon's Chicago and Cleveland plants carry complete stocks of Thermocouple Extension Lead Wire for practically every application. (See illustrations below.) This means that your order gets immediate delivery of a QUALITY product—one that meets Bureau of Standards Specifications. ORDER NOW! No waiting or delay. Prices available upon request.



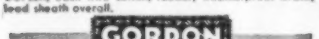
CHROMEL-ALUMEL, Cat. No. 1231(3-A), 14 ga., STRANDED-DUPLEX, each wire felted asbestos, Asbestos-yarn braid overall.

FOR PLATINUM THERMOCOUPLES, Cat. No. 1225, 16 ga., STRANDED-DUPLEX, each wire felted asbestos, Asbestos-yarn braid overall.

CHROMEL-ALUMEL, Cat. No. 1234, 14 ga., SOLID-DUPLEX, each wire enamel, felted asbestos, Asbestos-yarn braid overall.

IRON-CONSTANTAN, Cat. No. 1236-C, 14 ga., STRANDED-DUPLEX, each wire felted asbestos, Asbestos-yarn braid overall.

COPPER-CONSTANTAN, Cat. No. 1235-A, 14 ga., SOLID-DUPLEX, each wire cotton, rubber, weatherproof braid, lead sheath overall.



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CLAUD S. GORDON CO.

Specialists for 32 Years in the Heat Treating and Temperature Control Field

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Dept. 25 • 7018 Euclid Avenue • Cleveland 3, Ohio

Fisher Governor Company since 1930. He is a graduate mechanical engineer, and since 1934 has been the Pacific Coast sales manager for Fisher.

American Structural Sales Engineers Assume Duties

Lloyd

Keith

William A. Lloyd and Isaac Keith assumed duties as sales engineers for American Structural Products Company, a subsidiary of Owens-Illinois Glass Company, in Washington, D. C. and St. Louis, respectively on April 1. Lloyd's headquarters are 1627 K Street, N. W. and his territory includes Maryland, Virginia and part of North Carolina. Keith is located at 601 Continental Building. His territory comprises Kansas, Missouri, Arkansas, southern Illinois, western Kentucky, western Tennessee and northern Mississippi.

Lloyd previously was associated with National Vulcanized Fiber Company whereas Keith served as industrial sales engineer with Laclede Gas and Light Company and as plant engineer with Koppers Company.

Oronite Makes Changes

J. T. Deane, vice president of Oronite Chemical Company, a subsidiary of Standard Oil Company of California, will soon move to San Francisco from New Orleans to take charge of all Oronite manufacturing operations.

T. I. Clausen, former acting assistant to the manager of the chemicals division of California Research Corporation is transferring to Oronite as general superintendent in charge of manufacturing operations. He will make his headquarters at the company's Oak Point plant in New Orleans.

ERNST Liquid Level Gages

• Sight Flow Indicators
• Gage Glasses • Try Cocks
• Gage Glass Washers

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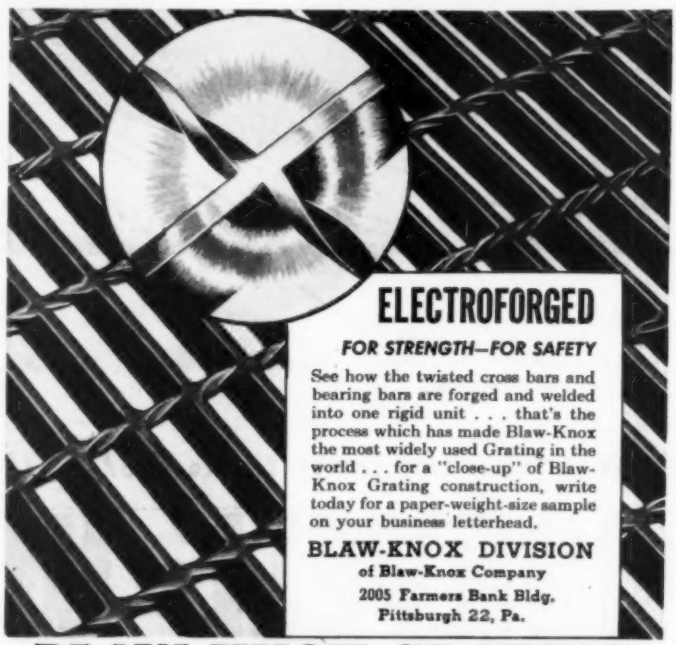

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Process Engineer: B. S. Chemical Engineering. Fluid Catalytic cracking specialist. Experienced in process engineering and plant operations. Desires permanent position in process engineering or operations with refiner needing engineer with catalytic cracking experience. Midwest or southwest preferred. Married, with family. Presently employed. Address Box 141-R, c/o Petroleum Refiner, Houston, Texas.

Chemical Engineer desires Engineering, Production, or Sales Position. Experience in Petroleum Development 4 years, Food Development 1½ years, Petrochemical Process and Job Engineering 4 years. Member ACS, AIChE, Tau Beta Pi. Winton Rochelle, Haworth, New Jersey.

Process Design and Development—MS in Chemical Engineering. Excellent experience in petrochemicals and synthetic fuels. Several publications. Present salary $6300. Will consider foreign service. Please state your agreement to confidential negotiations in reply. Address: Box 142-R, c/o Petroleum Refiner, Houston, Texas.

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Established chemical and industrial engineering group desires process and mechanical equipment items for sales or technical representation in Southern California area. Excellent contacts and qualifications in all phases oil, chemical and general industry fields. Address: Box 144-R, c/o Petroleum Refiner, Houston, Texas.

Outstanding Position Open

Engineer to direct Sales of Refinery process units. Qualifications to include sales and process engineering experience with major oil companies or petroleum engineering and contracting firms. Knowledge of oil refining process engineering plus economic evaluations and applications necessary. Age 35 to 45 years. Excellent compensation — salary and bonus. Location — New York or Tulsa. When replying state educational and experience background. Our own employees notified of opening. Address: Box 138-R, c/o Petroleum Refiner, Houston, Texas.

Contractors—Plant Owners

A COMPLETE LINE OF CONSTRUCTION TOOLS AND EQUIPMENT FOR INDUSTRIAL OR PROCESS PLANT CONSTRUCTION AND MAINTENANCE

Derricks, cranes, hoists, rigging specialties; winch trucks, pickups, jeeps; welding machines, acetylene torches; air compressors; pneumatic hammers, chippers and drills; electric saws, drills, drill presses, and grinders; pipe threading machines and tools; wheelbarrows, concrete carts, concrete buckets, vibrators, pumps, rod benders, shears; etc. — for BARE BASIS RENTAL.

Rentals by the Piece or Project

Charges are for rental only, plus our direct costs of handling, shipping, maintenance and reconditioning. Rental by written contract, with minimum rental period, on a monthly basis. Credit references will be needed at the time of inquiry.

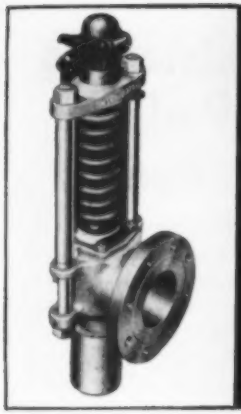
Advise your requirements and schedules

CONSTRUCTION TOOL & EQUIPMENT DIVISION, ROOM 1224-C

THE LUMMUS COMPANY, 420 Lexington Avenue, New York 17, N. Y.

Telephone: Murray Hill 9-2525 - Ext. 257

INSPECTION BY APPOINTMENT AT WAREHOUSE IN HOUSTON, TEXAS



New! CONSOLIDATED *Maxiflow* SAFETY VALVE

It solves the problem!

The CONSOLIDATED Maxiflow was designed and engineered to meet operating requirements of high pressure, high temperature steam generating equipment. A new addition to the CONSOLIDATED Safety Valve line, the Maxiflow answers the need for a valve with greater discharge capacity, shorter blowdown and other special characteristics not found in conventional safety valves.

Blowdown, adjustable to a low of 1%, is achieved by advantages no other safety valve possesses.

The CONSOLIDATED Thermodisc seat design—incorporated in the Maxiflow—guarantees a degree of tightness not found in any other safety valve.

Function, design, materials, weight, safety and space—all have been major considerations of creative engineering and unsurpassed workmanship in the development of the CONSOLIDATED Maxiflow Safety Valve.

We will be glad to send you a detailed bulletin concerning the Maxiflow.

MAXWELL MANNING M&M & MOORE INC. TRADE MARK

CONSOLIDATED SAFETY VALVES

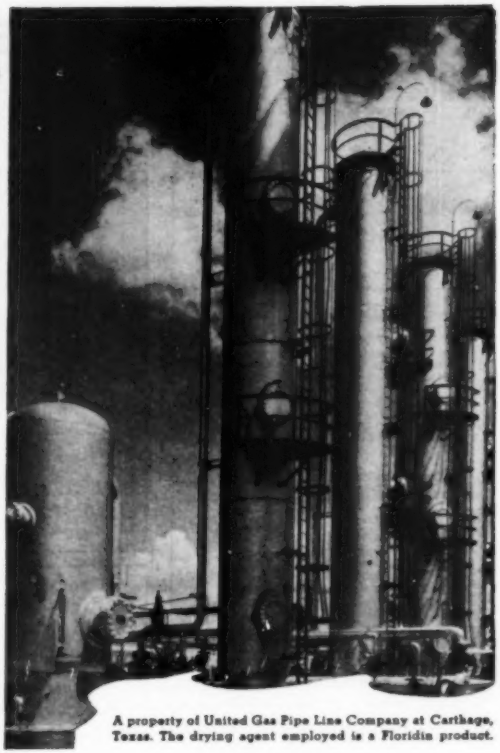
1870 CONSOLIDATED U.S.A.

A Product of

MANNING, MAXWELL & MOORE, INC.

BRIDGEPORT 2, CONNECTICUT

Makers of Consolidated Safety and Relief Valves, 'American' Industrial Instruments, Hancock Valves, Ashcroft Gauges. Builders of 'Shaw-Box' Cranes, 'Budgit' and 'Load Lifter' Hoists, and other lifting specialties.



A property of United Gas Pipe Line Company at Carthage, Texas. The drying agent employed is a Floridin product.

for **ADSORBENTS and DESICCANTS . . . turn to**

Floridin

FLOREX
FLORIGEL
FLORAID
FLORITE refining grade
FLORITE desiccant

FULLERS EARTH

Floridin is the oldest producer of Florida Fullers Earth and commands adequate supplies of raw materials from the finest natural deposits known anywhere. Extrusion and other special processes add greatly to effectiveness and adapt the product to specific uses. Correspondence is invited.

BAUXITE Made from the most suitable selected bauxite by special methods of activation and mechanical adaptation, Floridin products have been found superior to other granular desiccants for many industrial uses. More specific information will be given on request.

FLORIDIN COMPANY

ADSORBENTS

Department E, 220 Liberty St. Warren, Pa.

(A Quick Quiz on modern pH advancements)

Do you know these important facts about BECKMAN pH CONTROL?

Do you know...

That Beckman pioneered modern glass electrode pH equipment?

Until Beckman pH instruments were developed, glass electrode pH equipment was a cumbersome, complicated laboratory curiosity. It was Beckman that pioneered today's simple, compact, highly accurate and completely dependable glass electrode pH equipment!

That Beckman pioneered virtually every major development in modern glass electrode pH equipment?

Such far-reaching advancements as the High pH Glass Electrode . . . the High Temperature Glass Electrode . . . the Unusually Rugged "X-9" Glass Electrode . . . as well as a wide range of other vitally important advancements in glass electrode pH instrumentation, were *all* pioneered by Beckman. *Many of these advancements are still available exclusively in Beckman equipment!*

That Beckman offers the industry's most complete line of glass electrode pH instruments?

Included in the complete Beckman line are instruments specially designed to combine the high precision and wide versatility necessary for advanced research, medical and laboratory applications . . . others that combine maximum simplicity and high accuracy with complete portability for plant and field applications . . . still others that combine maximum simplicity and high accuracy with the plug-in convenience of full AC operation . . . plus *completely automatic* pH equipment for continuous pH indication, recording and control on large-scale processing applications.

That Beckman also provides the industry's most complete line of modern glass electrodes?

Although glass electrode pH instruments are the most efficient pH equipment obtainable, no glass electrode pH instrument is better than the versatility, accuracy and dependability of the electrode assemblies available for use with it.

Beckman provides the industry's most complete line of glass electrodes for use with Beckman pH instruments—a type of electrode assembly to meet every industrial, research, laboratory and field requirement!

That there are so many money-saving applications for Beckman pH control that you may be losing important profits unless you make a complete investigation of your operations?

There is pH wherever there's water, water solutions, moist pastes, sludges, slurries or other moisture-containing substances. And wherever there is pH, chances are the operation can be done better . . . with greater uniformity and less waste at lower overall cost . . . by Beckman-controlling the pH of the various processing operations.

WHETHER *you manufacture food products or treat sewage . . . do metal plating or refine crude oil . . . make textiles or process ore — in fact, no matter* WHAT *your field of operation . . . if you have not yet determined whether Beckman pH Control can be used to advantage in your operations — possibly is already* BEING *used to cut costs by your competitors — let us study your processes and make helpful recommendations. No obligation, of course.* BECKMAN INSTRUMENTS, NATIONAL TECHNICAL LABORATORIES, SOUTH PASADENA, 25, CALIFORNIA.

BECKMAN

For an informative, non-technical outline of modern pH control — what it is and how it's used — send for this free booklet "What Every Executive Should Know About pH."

INSTRUMENTS CONTROL MODERN INDUSTRIES

pH Meters and Electrodes — Spectrophotometers — Radiation Meters — Special Analytical Instruments

Mighty Mites

In Refinery Service

Those little traps with the big thirst—Yarway Impulse Steam Traps—are doing a giant's job in hundreds of refineries throughout the country.

Yarways are ideally suited not only for refinery work, but for all industrial trapping service. They literally *drink* the condensate—discharging *continuously* on heavy loads, *intermittently* on light loads. Hence they provide maximum heat in the shortest possible time to keep equipment at top efficiency.

Yarways are suitable for all pressures without change of valve or seat. Compact design makes them easy to install, and simplicity of construction (only one moving part) minimizes maintenance.

Next time old-type traps need repair, consider replacing them with Yarway Impulse Traps. New Yarways frequently cost less than the repair job. ***Over 600,000 have been bought!***

See your nearest Supply House, or write for Bulletin T-1739.

YARNALL-WARING COMPANY
128 Mermaid Ave., Philadelphia 18, Pa.

Ask about the Yarway 30-minute color and sound motion picture, with Lowell Thomas speaking—available for group showings.

YARWAY IMPULSE STEAM TRAP

GIVING BELTS THE HOTFOOT

. . . FOR A LONGER LIFE

QUAKER CONVEYOR BELTS PRE-TESTED 18 TIMES TO ASSURE LONG LIFE UNDER MOST SEVERE CONDITIONS

Whether it is moving rock on conveyor belts or driving a rig in the field . . . Quaker Belts are made to take the roughest wear. They're pre-tested and torture-tested when they are made to withstand every operating condition encountered in the oil industry.

One of the many tests Quaker Conveyor Belts must go through is shown above. A blowtorch, at high heat, held six inches from the surface of the belt for six minutes. Quaker Belts take it and are ready for more. They're tough, rugged and built for long wear. They're made for every application in the petroleum industry to assure less maintenance . . . to save loss of labor in repairs . . . to help reduce the "break-even point" in operations.

Whatever your need for industrial rubber products there's a Quaker Pre-tested Product for the Petroleum Industry. Power transmission belting . . . rod and sheet packings . . . moulded and braided hose . . . and all kinds of custom-made moulded rubber products. To economize it pays to Quakerize your operations.

HOSE THAT STANDS ABRASION

Hose for air, steam, water, oil, gas, fire or paint, Quaker makes it and makes it to fit the particular needs of industry . . . each length is pre-tested for peak performance.

BELTING FOR MAXIMUM HORSEPOWER

Flat belts or V-belts, Quaker has the one to fit the drive . . . to transmit maximum horsepower at the lowest operating cost . . . all pre-tested to assure peak performance.

QUAKER RUBBER CORPORATION

PHILADELPHIA 24, PA. • New York 7 • Cleveland 15 • Chicago 16 • Houston 1
Western Territory
QUAKER PACIFIC RUBBER CO. • San Francisco 10 • Los Angeles 21 • Seattle 4

QUAKER

RUBBER PRODUCTS

QUAKER RUBBER COLLABORATION
PHILADELPHIA PA
QUALITY SINCE 1918
REG. U.S. PAT. OFF.

WARREN PETROLEUM CORPORATION DRIES BOTH LIQUID AND GAS WITH ALCOA ACTIVATED ALUMINA

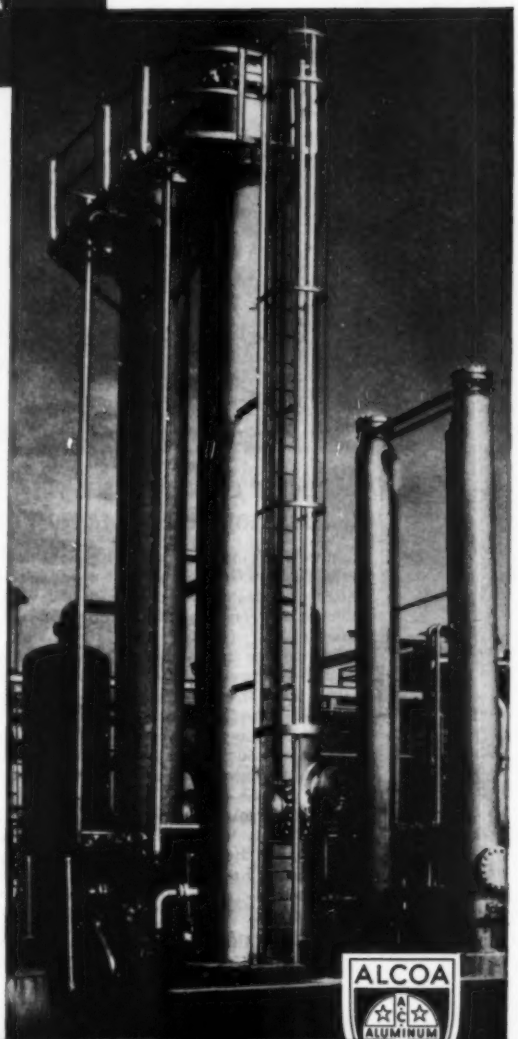
Because ALCOA Activated Alumina is economical for dehydrating both liquids and gases, Warren Petroleum Corporation uses it to dry liquid propane and residue gas to *minus* 40° F. dew point, at their Holliday, Texas, plant.

The larger pair of towers in the photograph are the residue gas dehydrators through which approximately 13 million standard cubic feet of gas is passed per day at a working pressure of 800 psig. Gas enters the towers at 80° F. to 90° F. Regeneration is accomplished in 4 hours with natural gas heated to 380° F., after which the tower is cooled before being put on stream.

The smaller pair of towers dehydrate 35,000 gallons of liquid propane per day at a working pressure of 215 psig. The liquid enters the towers at 80° F. to 90° F. Natural gas, heated to 380° F., is used for regeneration.

This is a typical example of ALCOA Activated Alumina "at work"—a desiccant that dries *both* liquids and gases quickly and efficiently. It also adsorbs certain gases and vapors from gaseous mixtures. Let us tell you more about this versatile drying agent. Write to: ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 1963 Gulf Building, Pittsburgh 19, Pennsylvania.

Dehydrating units at Warren Petroleum Corporation, Holliday, Texas. Towers at left dry residue gas. Those at right dry liquid propane. All four towers charged with Alcoa Activated Alumina.



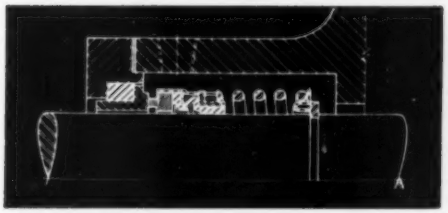
ALCOA CHEMICALS

ALUMINAS AND FLUORIDES

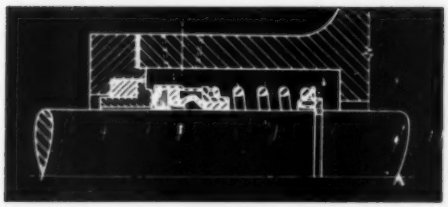
ACTIVATED ALUMINAS • CALCINED ALUMINAS • LOW SODA ALUMINAS • TABULAR ALUMINAS • HYDRATED ALUMINAS
ALUMINUM FLUORIDE • SODIUM FLUORIDE • SODIUM ACID FLUORIDE • FLUOBORIC ACID • CRYOLITE

FACTORS IN SHAFT SEAL DESIGN BY JOHN CRANE

The Importance of Flexibility in the Mechanical Seal



"John Crane" Type 1 Shaft Seal installed in stuffing box in position for use.



Axial movement required to compensate for wear and manufacturing tolerances.

The above installation drawings illustrate one of the important phases of flexibility in mechanical seal construction.

Manufacturing tolerances and wear require that the shaft seal provide axial tolerance without loss of sealing efficiency. It is vitally important that the flexing member be designed so that low pressure insures proper movement under installation and operating conditions, since low spring loading minimizes friction and reduces wear.

The "John Crane" Shaft Seal has been engineered to insure complete flexibility, in both axial and radial tolerance requirements. When considering the use of a mechanical seal, why don't you have a "John Crane" engineer show you shaft seal models and engineering data on metals, carbons and rubber or neoprene stocks?

Good Mechanical Seal Design is important. Our wide experience may be valuable to you in the start of a new design.

A special bulletin describes the operation of this Shaft Seal in detail. We'll be glad to send you a copy.

CRANE PACKING COMPANY
1820 CUYLER AVENUE • CHICAGO 13, ILLINOIS

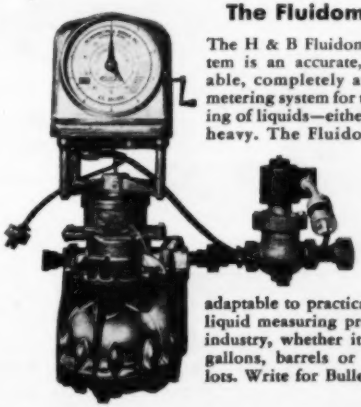
Complete

Jacketed Pipe and Fluidometer Systems

For All Liquid Handling Problems

H & B Jacketed Pipe Systems are engineered and manufactured to meet every requirement of dependable and economical processing in operations where the maintenance of uniform temperature in the process pipes is highly essential. Regardless of whether the product being handled requires a hot or cold temperature, or what heating or cooling medium is used, H & B Jacketed Pipe and Fittings help assure efficient production. Write for Bulletin S-47.

The Fluidometer



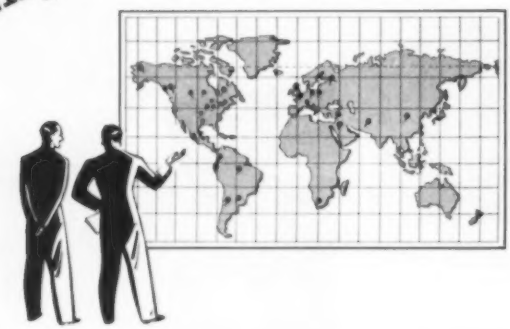
The H & B Fluidometer System is an accurate, dependable, completely automatic metering system for the batching of liquids—either light or heavy. The Fluidometer is adaptable to practically every liquid measuring problem in industry, whether it involves gallons, barrels or tank car lots. Write for Bulletin F-46.

HETHERINGTON & BERNER INC.
743 Kentucky Avenue, Indianapolis 7, Indiana

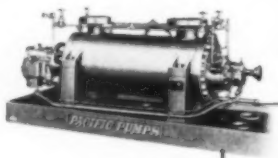
FOR THE BEST IN PRODUCTS AND SERVICE

Engineers the World over specify

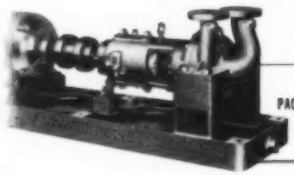
PACIFIC *Precision Built* PUMPS



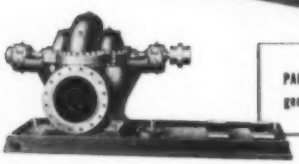
Engineered to the service requirements
Hydraulically designed for sustained efficiency
Mechanically designed for endurance and simplicity



PACIFIC TYPE **I**
hot charge pump



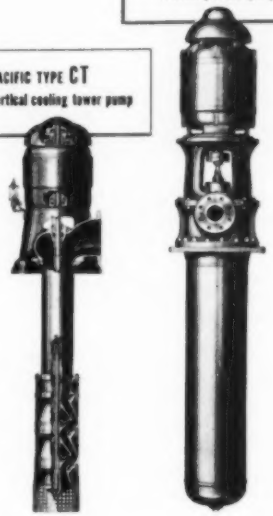
PACIFIC TYPE **SVC**
process pump



PACIFIC TYPE **DC**
general service pump

PACIFIC TYPE **WY**
vertical process pump

PACIFIC TYPE **CT**
vertical cooling tower pump



Pacific builds a complete line of Vertical and Horizontal Single and Multi-stage Pumps in all capacities, pressures and temperatures

25 YEARS

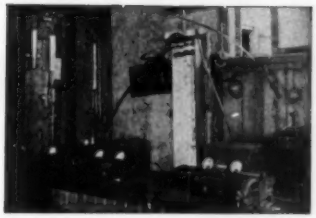
PACIFIC *Precision Built* **PUMPS**

PACIFIC PUMPS INC. HUNTINGTON PARK, CALIFORNIA
One of the Dresser Industries
Export Office: Chanin Bldg., 122 E 42nd St., New York
Offices in All Principal Cities

C-1

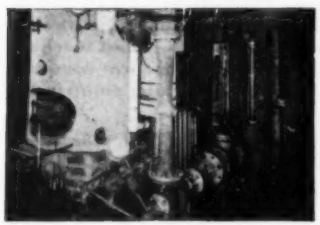
What's *behind* a CROLL C R REYNOLDS Evactor?

1



Instruments in the CR laboratory set up for measuring extremely high vacuum.

The production of Evactors is no routine operation at the Croll-Reynolds plant. Although CR engineers have over thirty years of industrial vacuum experience to guide them, the Croll-Reynolds testing and development department is one of the important units of the company. Development work is constantly under way to improve the efficiency of Croll-Reynolds Evactors wherever it is possible. It is this never-ending research and development which give CR Evactors their exceptional efficiency.



2

Special boiler in the CR pilot plant for providing unusual conditions of high pressure steam or superheat (or both) to duplicate the working conditions in customers' plants.

3

A 30-inch CR Booster Evactor on test in a CR shop.

CROLL C R REYNOLDS

CROLL-REYNOLDS CO.

17 JOHN STREET, NEW YORK 7, N. Y.

CHILL VACTORS STEAM JET EVACTORS CONDENSING EQUIPMENT

Safe, Accurate Transmission of Pressure Indications up to 1000'

The new Ashcroft Pneumatic Pressure Transmitter is a safe, accurate *and economical* method of transmitting pressure indications from their originating source to a central control point.

Employing *only low air pressure*, this new transmitter is particularly suitable for use in those industries where hazards of fire and explosion exist.

The Ashcroft Pneumatic Transmission system consists of a transmitter capable of measuring any pressure from *15# up to 50,000# per square inch* and delivering low pressure air—proportional to the indicated pressure—to a distantly located Receiver Gauge. Long, high pressure lines are avoided. Inflammable, poisonous or corrosive liquids and gases are confined close to their source.

The overall accuracy of the entire system—transmitter and receiver—is within ½ of 1%.

If you require the transmission of pressure indications *over 1000'*, the new Microsen Electronic Transmitter is available. Detailed bulletins describing both the Ashcroft Pneumatic and the Microsen Electronic Pressure Transmitter are available upon request.

MAXWELL MANNING MOORE TRADE MARK

ASHCROFT *Gauges*

A Product of

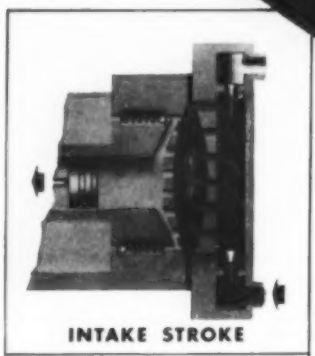
MANNING, MAXWELL & MOORE, INC.

STRATFORD, CONNECTICUT

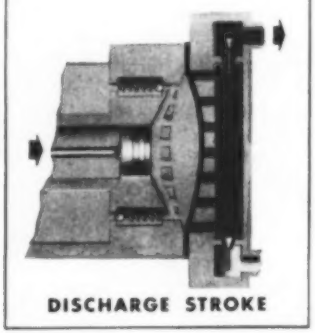
Makers of Ashcroft Gauges, Hancock Valves, Consolidated Safety and Relief Valves and 'American' Industrial Instruments. Builders of 'Shaw-Box' Cranes, 'Budgit' and 'Load Lifter' Hoists and other lifting specialties.

NO STUFFING BOX

Lapp PULSAFEEDER
PISTON-DIAPHRAGM PROPORTIONING PUMP



INTAKE STROKE



DISCHARGE STROKE

● Operation of the Lapp Pulsafeeder depends on no mechanical or liquid seal; no packing or other "leak-likely" gland can be in contact with liquid being handled. Instead, a hydraulically-balanced diaphragm acts as a floating partition, without mechanical load or pressure differential across it. This assures complete isolation of chemicals being pumped from all working pump parts.

HYDRAULICALLY-BALANCED DIAPHRAGM, made from the most suitable of several available materials, is confined by machined "dishes" within its fatigue limit, secure against failure.

CHEMICAL ISOLATED by diaphragm from working parts of pump.

MICRO-ADJUSTABLE to any rate of flow by calibrated handwheel, *while pump is in operation.*

PERFECT LUBRICATION — all moving parts submerged in oil bath.

CAPACITY ranges from less than 100 ml. per hour to 660 gallons per hour; pressures up to 2250 psig. Single head and duplex models are available in a range of four sizes.

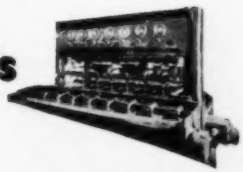
SEND FOR BULLETIN No. 262 which carries complete description and specifications. Lapp Insulator Co., Inc., Process Equipment Division, 165 Maple St., Le Roy, N. Y.

Lapp *Process Equipment*

CHEMICAL PORCELAIN VALVES
PIPE • RASCHIG RINGS
PULSAFEEDER PROPORTIONING PUMPS

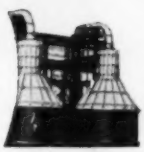
LEAD LININGS

...blunt the teeth of Hungry Acids

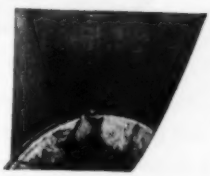


In unnumbered processing plants across the country, sheet lead plays a vital role in keeping acids under control. Because, among other unique properties given lead by nature, is *stern resistance to corrosion.*

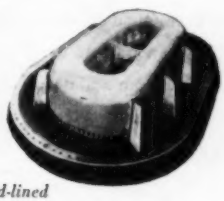
It is this innate ability to blunt the teeth of hungry acids, coupled with several of lead's other "abilities"—adaptability, workability, durability and availability—that makes the use of lead a virtual "must" as a lining for tanks, tubs and vats in which corrosive liquids are handled, moved or stored.



National Lead markets sheet lead of several types—chemical, antimonial, tellurium and antimonial-tellurium. Each has its functional place in the processing field. All are produced with a know-how that makes the most of the metal's inherent qualities. From starting slab to sturdy sheet, the rolling is done under the watchful eyes of experienced operators. The sheet comes off the cutting table smooth, uniform, and true to weight and dimensional specifications.



If your acid-handling activities demand lead's unusual combination of properties, use National Lead sheet. And if you would like our views on ways and means of getting optimum results from sheet lead installations, consider us at your service.



Look to the Leader for Lead

...in everything from lead pipe...valves...sheet...and lead-lined or lead-covered equipment...to complete acid recovery plants

NATIONAL

Lead Company

New York 6; Baltimore 3; Buffalo 3; Chicago 8; Cincinnati 3; Cleveland 13; Pittsburgh 12; St. Louis 1; Boston 6 (National Lead Company of Mass.); Los Angeles 23 (Morris P. Kirk & Son, Inc.); Philadelphia 25 (John T. Lewis & Bros. Co.); Atlanta (Georgia Lead Works, Div. of Cincinnati Branch); Toronto, Canada (Canada Metal Co. Ltd.).

General Chemical "ALUM"

For Treatment of Industrial Wastes

Treatment of industrial wastes to prevent harmful effects on public waters is becoming increasingly important. Throughout the process industries, scores of concerns have found a solution to their problem in the use of General Chemical Aluminum Sulfate.

Laundries, paper mills, dairies, textile mills, canning plants, oil wells and packing houses across the nation report General Chemical "Alum" useful in purifying wastes; coagulating and settling suspended matter; reducing coloring matter, including many dyes.

Fifty years of working with the water industry on chemical methods of clarifying water has given General Chemical extensive experience in the treatment of sewage and waste waters. This broad knowledge may be of value to you as it has to so many others.

Assistance of the company's technical service specialists is available on request—and without obligation. For help on your industrial waste treatment problems, write or phone the nearest General Chemical office.

50 YEARS OF SERVICE

BASIC CHEMICALS

GC

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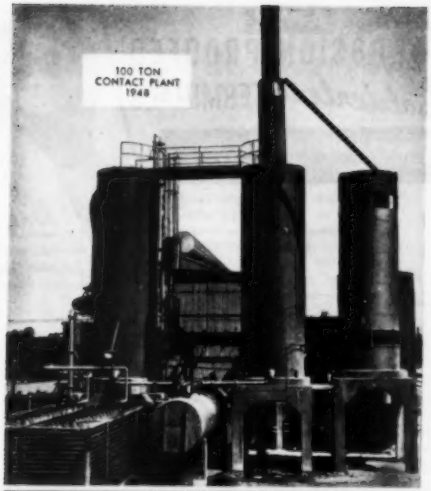

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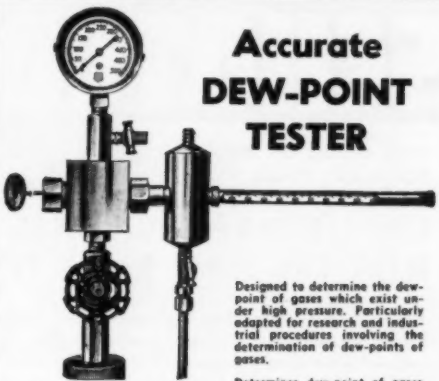

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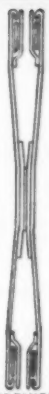
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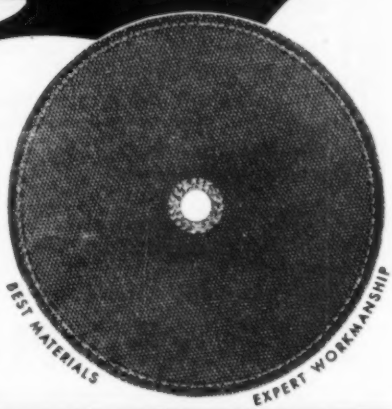

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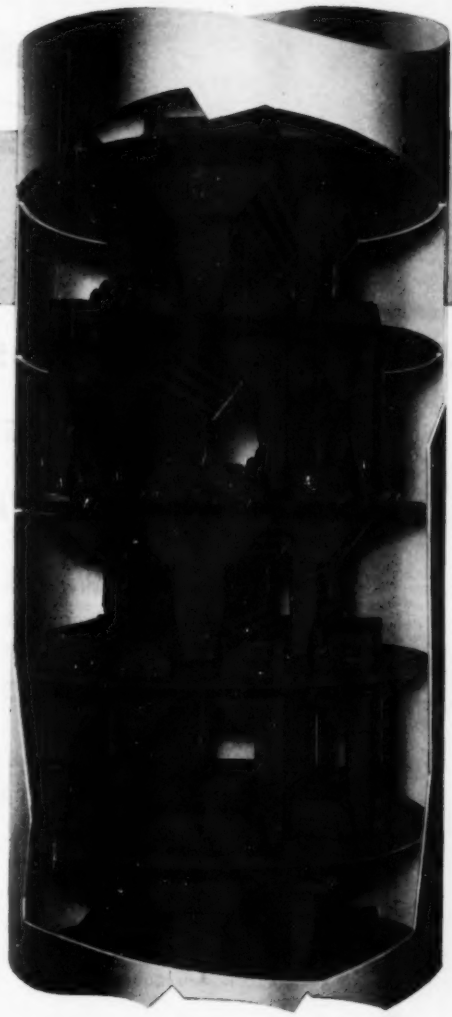

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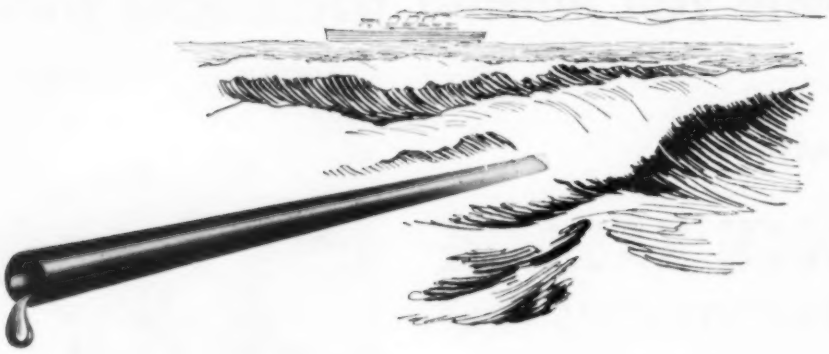

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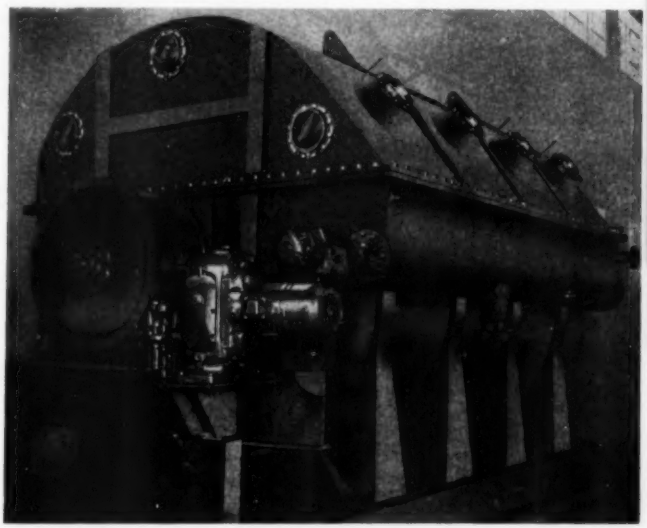

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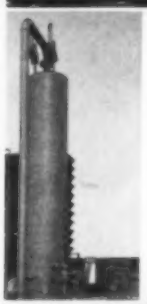

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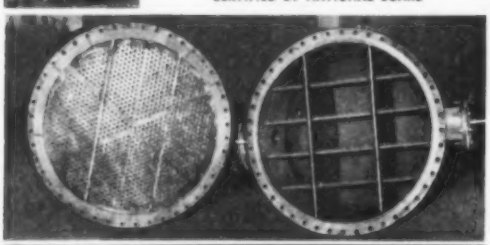

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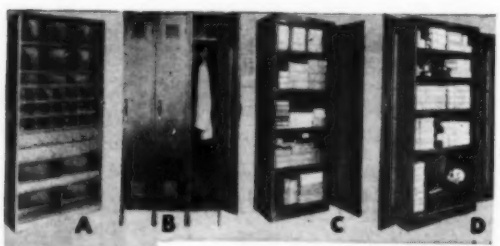

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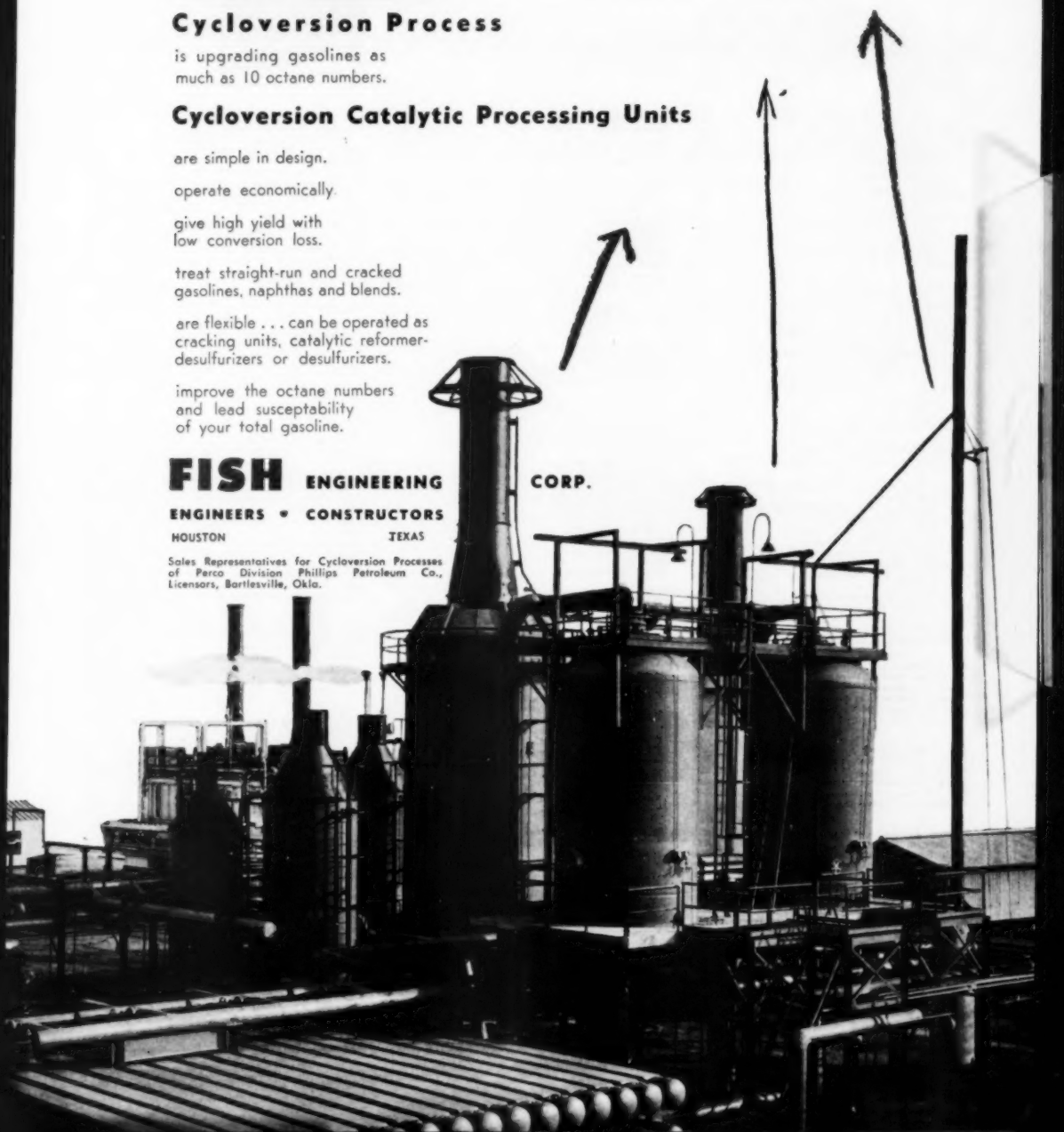

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For use with any media whose viscosity may require provision for periodic cleaning of gauge. Upper housing is of alloy steel with a specially designed seat to receive the corrosion resistant diaphragm on a tapered fit, metal to metal seal. Diaphragms are available in stainless steel, aluminum, tantalum, Neoprene and in silver and other precious metals. Mounting flange supplied as standard in forged steel. Ranges: 30" vacuum to 400 lbs. p.s.i.

ELECTRIC ALARM GAUGES

Pressure actuated, high-capacity, snap-action switches with accurate repeatability and low switching differentials. For use on hydraulic pumps, presses, etc., or for use as a signaling or control mechanism for low and high tank levels or pressures. Type V is a non-indicating switch containing 2 independent, single pole, double throw switches actuated from a single bourdon tube. Type VI is identical to type V but is equipped with a second independent bourdon tube so that the indicated pressure is entirely independent of the element actuating the switches. Ranges: 0 to 30" vacuum, 15 to 20,000 lbs. p.s.i.

US GAUGES—BETTER INSIDE...BETTER OUTSIDE...BETTER ON YOUR PRODUCT

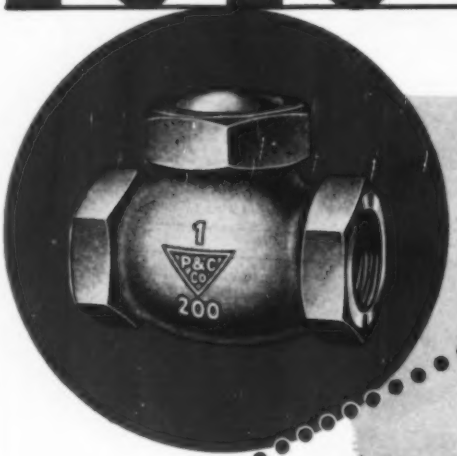
UNITED STATES GAUGE

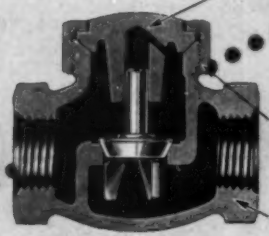
PRODUCTS OF UNITED STATES GAUGE... Absolute Pressure Gauges • Aircraft Instruments • Air Volume Controls • Altitude Gauges • Boiler Gauges • Chemical Gauges • Dial Thermometers • Glass Tube Thermometers • Flow Meters • Inspectors' Test Gauges • Laboratory Standard Test Gauges • Marine, Ship and Air-Brake Gauges • Recorders • Controls and Alarm Gauges • Voltmeters • Ammeters • Welding Gauges

R·P&C

BRONZE LIFT CHECK VALVES

designed and built to take ***PUNISHMENT***





1 CAP—forms an efficient beveled joint with the body. The integral disc guide has long contact with the disc stem for perfect alignment and resulting free movement and positive seating. It also cushions disc movement.

2 UNION NUT—heavy and rugged. Can be removed and replaced without danger of distorting the body or weakening threads.

3 BODY—has heavy section at cap joint and end hex with long contact end threads. Seat is integral with body.

THESE BRONZE LIFT CHECKS—rated 200 pounds and 300 pounds—are especially suited to prevent back-flow on high velocity line or where flow is pulsating. Shut-off is quick, positive and tight. For use in horizontal lines only. • (On low or moderate velocity lines, R-P&C swing checks are recommended.) • Get in touch with the nearest R-P&C District Office or R-P&C Distributor for information about Check Valves.

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Top Performance

COOLING TOWERS

Below - An installation of HUDSON water cooled atmospheric sections

IMPROVED AIR FLOW AND AIR-WATER CONTACT

Unique deck design reduces air pressure drop and establishes positive counter current contact between air and water. Tapered sides of the tower eliminate dead space and decrease air turbulence.

LOWER OPERATING COST

Low pumping head and low fan horsepower result in perpetual power savings.

ECONOMY IN FABRICATION AND ERECTION

Prefabricated sections are designed for mass production and easy field assembly.

GREATER STRUCTURAL STRENGTH

Bridge truss type framework with improved timber connectors develops maximum strength in load bearing members.

Undivided Responsibility

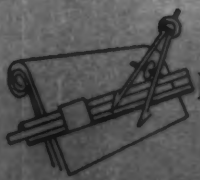
Complete integration in selection and design of cooling tower with coolers, results in cooling systems of minimum first cost and minimum operating cost... and the responsibility is undivided.

ENGINEERS *CONSTRUCTORS*

HUDSON ENGINEERING CORPORATION

FAIRVIEW STATION HOUSTON, TEXAS

HOW Patterson HANDLES YOUR COMPLETE CONTINUOUS PROCESSING PROJECT



ENGINEERING

Patterson's staff of Process Engineers, with its collective experience in DESIGN, MANUFACTURE, CONSTRUCTION, OPERATION, provides one of the many safeguards against costly difficulties, and is your assurance that from the planning stage, proven and practical methods of manufacture, erection and operation will be specified.

MANUFACTURING

Patterson's modern plant, with up-to-date equipment, manned by personnel skilled by years of experience in the production of apparatus for the chemical and process industries, provides complete facilities for the manufacture of your equipment in strict accord with specifications—without compromise—without outside aid—passing the savings on to you.

CONSTRUCTION

Stressing the functional, Patterson plans its process plants around the sound requirements of safety, operating economy and the pride of the builder and operator in a workmanlike establishment. Through highly experienced field erection and with reliable construction personnel, you are never required to maintain any but the services actually needed for the construction of your plant.

OPERATION

Patterson, as the designer of process plants, is responsible also for their operation. We know what went into the plant, where and why. Every instrument, control and location has had personal attention. We know our responsibility does not cease until after the completion of the trial run and your unqualified acceptance, and, when desired, until your operating staff is properly trained.

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wire—for action!

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